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# CONSERVATION DESIGN GUIDELINES FOR BOTANIC GARDENS

by

C. Craig Houston

A thesis submitted in partial fulfillment  
of the requirements for the degree

of

MASTER OF LANDSCAPE ARCHITECTURE

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Logan, Utah

2009

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## ABSTRACT

## Conservation Design Guidelines for Botanic Gardens

by

C. Craig Houston, Master of Landscape Architecture

Utah State University, 2009

Major Professor: Peter Kumble

Department: Landscape Architecture and Environmental Planning

Botanic gardens worldwide are asked to be centers of conservation. However, little is written about conservation-specific planning and design forms botanic gardens should use to fulfill this assignment. After looking at the history of botanic gardens, with a focus on the purpose/design relationship, examining design guidelines suggested in and inferred from the literature, and presenting habitat conservation principles and sustainable construction guidelines from other areas of practice, the author developed conservation design guidelines for botanic gardens focused on conservation. The guidelines address the following five categories: (1) Mission Statement and Site Character, (2) Presentation of Native Habitats, (3) Presentation of Native Plants in Man-made Landscapes, (4) Sustainable Practices in Daily Operations, and (5) Educational Components. To illustrate the guidelines, they were applied in a hypothetical, conceptual redesign of the Belize Botanic Gardens, located near San Ignacio, Belize.

(207 pages)



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Christopher Craig Houston

## CONTENTS

v

	Page
ABSTRACT .....	iii
ACKNOWLEDGMENTS .....	iv
LIST OF FIGURES .....	vi
CHAPTER	
1.    INTRODUCTION AND PROBLEM STATEMENT .....	1
2.    LITERATURE REVIEW.....	4
3.    METHODOLOGY .....	55
4.    INTRODUCTION TO CONSERVATION DESIGN GUIDELINES FOR BOTANIC GARDENS .....	57
5.    PROPOSED CONSERVATION DESIGN GUIDELINES FOR BOTANIC GARDENS .....	66
6.    ILLUSTRATIVE EXAMPLE .....	76
7.    CONCLUSION .....	102
REFERENCES .....	114
APPENDIX .....	121

## LIST OF FIGURES

Figure	Page
2-1 Timeline of Botanic Garden Historical Groups .....	9
5-1 Site Conditions Pre-Development.....	69
5-2 Concept Illustration of How to Plan Around Existing Vegetation.....	70
5-3 Example of How Not to Treat Native Vegetation.....	71
5-4 One Way of Pulling Native Vegetation into Garden .....	72
5-5 Introducing a Corridor through a Garden .....	73
5-6 Ways of Maintaining a Corridor through a Garden.....	74
6-1 Location of Belize Botanic Gardens.....	76
6-2 BBG Existing Conditions.....	80
6-3 BBG Location in Context with Immediate Surroundings .....	81
6-4 BBG Location in Regional Context .....	81
6-5 General Character of Existing Vegetation .....	82
6-6 Proposed Areas of Expanded Native Vegetation and Corridors .....	83
6-7 BBG Concept Plan Showing Garden Rooms.....	84
6-8 Areas Where Natural Processes Will Be Allowed .....	86
6-9 Proposed Vegetation Corridors for Wildlife .....	88
6-10 Clustering of Buildings .....	90
6-11 Possible Arrangement of Habitat Displays in BBG .....	92
6-12 Sample Views from within BBG .....	93
6-13 Formal Arrangement of Native Plants around Garden Entrance.....	94

	vii
6-14 Mission Statement Prominently Displayed at Garden Entrance.....	97
6-15 Potential Sensory Garden Locations .....	100
6-16 Belize Botanic Gardens' Conservation Concept Plan .....	101
A-1 BBG Proposed Concept Plan .....	127
A-2 Abstracted Belizean Habitat Continuum as Proposed for Display at BBG .....	131
A-3 Suggested Interpretive Display Locations.....	139
A-4 Entrance Boulevard Cross Section .....	142
A-5 Level One Trail Cross Section .....	142
A-6 Level Two Trail Cross Section .....	143
A-7 Typical Intersection of Level One and Level Two Trails, with Shade Structure .....	144
A-8 Typical Intersection of Level One Trail and Maya Trail .....	144
A-9 Typical Intersection of Level Two Trails in the Inner Garden with Shade Structure .....	145
A-10 Typical Intersection of Level Two Trails in the Outer Garden .....	145
A-11 Typical Intersection of Level Two Trail and Maya Trail .....	146
A-12 Typical Intersection of Level Two Trail and Road Closed to Public Access .....	146
A-13 Main Entrance with Interpretive Signage .....	147
A-14 Main Entrance with Optional Walls and Planters .....	147
A-15 Central Node with Sign Post .....	148
A-16 Suggested Shade Structure.....	148
A-17 Directional Signage Suggested Locations and Orientation .....	149

A-18	Posting Configuration of Directional Signs—Inner and Outer Gardens .....	150
A-19	Outer Garden Directional Signs .....	150
A-20	Inner Garden Directional Signs .....	151
A-21	Plants of the Maya Directional signs .....	151
A-22	Suggested Self-Guided Tour Pointer Options Based on Maya Glyphs .....	152
A-23	Posting of Self-Guided Tour Signs in Inner Garden .....	152
A-24	Self-Guided Tour Signs for Outer Garden—Separate and On Post.....	152
A-25	Sample Locational Signs .....	153
A-26	Sample Interpretive Sign.....	154
A-27	Upright Interpretive Sign .....	154
A-28	Angled Interpretive Sign.....	155
A-29	Sample Sponsorship Sign—Neutral/Natural Colors, Simple Patterns .....	155
A-30	Guidelines for Fully-Enclosed Buildings, Based on Conference Center .....	156
A-31	Guidelines for Open Buildings, Based on Maya House .....	157
A-32	Guidelines for Special Plant Collections and Special Purpose Buildings .....	157
A-33	Guidelines for Stone Retaining and Other Walls, Option 1 .....	158
A-34	Guidelines for Stone Retaining and Other Walls, Option 2 .....	158
A-35	Guidelines for Wooden Retaining Walls.....	159
A-36	Symmetrical Plantings at a Transition Point or Gateway .....	160
A-37	Improper (left) and Proper (right) Placement of Gateway Plantings.....	161

A-38	Mass/Space Diagram of BBG .....	162
A-39	Edges Should Taper from Ground Level to Canopy .....	163
A-40	Plan View of Mingled Drift—No Hard Edge.....	163
A-41	Example of Balance through Symmetry.....	164
A-42	Example of Balance through Contrast—Formal Plantings (left) and Naturalistic Plantings (right) .....	164
A-43	Example of Contrasting Textures and Forms that Balance Each Other.....	165
A-44	Example of Counter-Balanced Plantings .....	166
A-45	Plant Massing Principles.....	168
A-46	Trail Implementation Phases .....	170
A-47	Belize Botanic Gardens Master Plan Illustrative .....	172
A-48	Dimensions for Inner Garden Directional Signs .....	175
A-49	Dimensions for Outer Garden Directional Signs .....	176
A-50	Dimensions for Outer Garden Self-Guided Tour Signs.....	177
A-51	Dimensions for Upright Interpretive Signs.....	178
A-52	Dimensions for Angled Interpretive Signs—View 1.....	179
A-53	Dimensions for Angled Interpretive Signs—View 2.....	180
A-54	Interpretive Sign Array Model .....	181
A-55	Entrance Interpretive Sign Array Dimensions—View 1 .....	181
A-56	Entrance Interpretive Sign Array Dimensions—View 2.....	182
A-57	Entrance Interpretive Sign Array Dimensions—View 3.....	183
A-58	Entrance Interpretive Sign Array Dimensions—View 4.....	184
A-59	Proposed Entrance Sign Dimensions .....	185

	x
A-60 Shade Structure Dimensions—View 1 .....	186
A-61 Shade Structure Dimensions—View 2 .....	187
A-62 Shade Structure Dimensions—View 3 .....	188
A-63 Dimensions for Standard Intersection of a Level 1 and a Level 2 Trail .....	189
A-64 Dimensions for Standard and Non-Standard Intersections of Two or More Level 2 Trails .....	190
A-65 Dimensions for the Central Node .....	191
A-66 Entrance Reference Model for Dimensions that Follow .....	192
A-67 Step One Entrance Construction Dimensions .....	193
A-68 Step Two Entrance Construction Dimensions .....	194
A-69 Step Three Entrance Construction Dimensions .....	195
A-70 Step Four Entrance Construction Dimensions .....	196
A-71 Entrance Vertical Dimensions—View 1 .....	197
A-72 Entrance Vertical Dimensions—View 2 .....	197
A-73 Entrance Vertical Dimensions—View 3 .....	197

## CHAPTER 1

### INTRODUCTION AND PROBLEM STATEMENT

Botanic gardens in the Western world have a long history, beginning with the first European medicinal garden founded in Pisa, Italy in 1543 (Heywood 1987). As will be shown in the literature review, much has been written about botanic gardens since that time, covering topics such as purpose, programming, research, collections preservation, and how they can properly perform as guardians of biological diversity. The literature review will also show that the subject of physical design and planning for botanic gardens in general has received due attention.

The purpose of the first botanic garden (1543) was to grow plants with medicinal properties for study by medical students. In the centuries that followed, botanic garden purpose has changed. In addition to providing medicinal source material, these gardens have served as centers for identifying and cataloging newly discovered plants, propagating plants with economic or horticultural potential, and educating the general public about plants and their characteristics (Heywood 1987). Now, modern botanic gardens are being asked to fill yet another need, that of a conservation center for native, rare, and endangered plants (Heywood 1987).

The planning and design of botanic gardens has historically changed over time to reflect changes in purpose, changes in science, and changes in the cultural trends and aesthetics of the time. For example, the geometric designs and narrow planting beds of the first botanic gardens reflected the dominant



design philosophies of the day and the practical needs of the gardens' users (Byrd 1989; Prest 1981). These forms endured for centuries because they adapted well to systems of categorization and classification, as well as scientific needs, that developed later. Changing circumstances and cultural preferences eventually caused botanic gardens to change the forms and styles they used until, in the 1800s, botanic gardens adopted a park-like plan and aesthetic similar to the pleasure grounds of the time (Evans 1999; Lighty 1989; Byrd 1989). This can be seen at the Royal Botanic Gardens, Kew, where, around 1850, government officials responsible for the gardens began to see them as public recreation facilities and dramatically increased the numbers of floral displays (Evans 1999). This last change was made in order to attract the public, and the park-like plan and aesthetic continued to be used well into the twentieth century. However, these design elements may not meet the needs of the next generation of conservation botanic gardens, and their appropriateness as models is therefore in question (Robertson 1989).

How, then, should a conservation botanic garden be planned and designed? Should it be planned or designed differently from other types of botanic gardens? If so, what formal styles should it implement? These questions have not been directly addressed in the literature, although the potential inappropriateness of traditional forms has been (Robertson 1989). This thesis will look at these questions and posit answers to them. Specifically, it will propose planning and design guidelines for conservation botanic gardens intended to help these achieve their potential as centers of conservation.

Before proceeding with the literature review, it will prove helpful to clearly define some terms that will be used throughout. The first two terms are “conservation” and “ecology.” The definitions of these terms and the differences between them help clarify what is meant in the current context by “conservation botanic garden.” The word “conservation” means the careful protection or planned management of a thing, especially a natural resource, to prevent its destruction (*Merriam-Webster's Collegiate Dictionary* 2003). The word “ecology” is defined as the science dealing with the relationships between organisms and their environments (*Merriam-Webster's Collegiate Dictionary* 2003). Based on these two definitions, a conservation botanic garden will intentionally focus on protecting and managing natural resources. An ecological botanic garden, on the other hand, could present and interpret ecological systems for the purpose of public education without carrying on any conservation work or otherwise having a role in conservation. This thesis will deal with the former type of garden.

Additional terms that will be used throughout, and that may require clarification, are “botanic” vs. “botanical” and “garden” vs. “gardens.” Which terms are used in the title of a specific institution is likely an arbitrary choice made when a garden is named (Gager 1938). This work will use “botanic garden” unless referring to the proper name of a specific garden or to botanic gardens in general.

## CHAPTER 2

### LITERATURE REVIEW

To provide background and context for the planning and design guidelines proposed later, the literature review focused on finding answers to the following questions: First, what is a botanic garden, and what is a conservation botanic garden? Second, what purposes have botanic gardens served over time, and what purposes do they serve now? Third, what planning and design principles and forms were historically used in botanic gardens, and what purposes did they serve? Fourth, what design principles and forms have been used in botanic gardens over the last 20 to 30 years? Fifth, what planning and design guidelines have been suggested, or might be inferred, for modern botanic gardens in the relevant literature? Sixth, what design guidelines have been suggested for related institutions such as ethno-botanic gardens?

#### **QUESTION 1: WHAT IS A BOTANIC GARDEN?**

This discussion will begin by defining the term “garden” in order to clarify what makes a botanic garden different from other gardens. A garden has been defined as a place in which the plants and semi-natural vegetative communities most appealing to humans are gathered (Hitchmough and Dunnett 2004); as a place which is enclosed and in which plants are deliberately placed for human use, such as food or comfort (Huxley 1978); as a controlled and nurtured space separated from neighboring natural and urban areas (Folsom 2002); and as an

outdoor space set apart for the use and enjoyment of man (Kuck 1984). As a garden, a botanic garden may rightly claim any one or all of these characteristics.

The meaning of botanic garden may be further clarified by addressing the difference between public gardens and botanic gardens, which is frequently blurred in the literature. An early definition used by the International Association of Botanic Gardens said that a botanic garden was any garden or arboretum with its plants labeled and open to the public (Wyse Jackson and Sutherland 2000). One author claims the difference lies in the amount of focus on scientific research and specialization (Byrd 1989). Botanic gardens will very clearly do both, while public gardens are more multidimensional and attempt to cater to the public as their first priority, and often in lieu of research (Byrd 1989). Another author says there is no hard definition for what constitutes a botanic garden, as the edges between scientifically-based gardens, public parks, and private collections are blurred (Wyse Jackson and Sutherland 2000). In practice, many botanic gardens refer to themselves as “public gardens,” as evidenced by the title of the journal of the former American Association of Botanical Gardens and Arboreta, now the American Public Gardens Association. The journal’s new title is *Public Garden*.

In spite of this apparent migration toward a more public focus in botanic gardens, many authors have attempted to establish a hard line based on scientific purpose and activity. One definition from the late 1930s describes a botanic garden as a garden established for the primary purposes of research or instruction, specifically excluding public parks with labels on the trees, and

certain private collections (Gager 1938). Other definitions require that a botanic garden manage its plant collections in a scientific way and have a purpose other than pleasure or amenity (Heywood 1987); be a place where plants can be collected, cultured, and studied for scientific and display purposes (Byrd 1989); arrange its living collections according to an accepted classification system (Byrd 1989); have research as a fundamental focus of its operations (Meilleur 1991; Mielcarek 2000); actively use its collections for scientific purposes (Wyse Jackson 1991; Wyse Jackson and Sutherland 2000); and have its living collections documented (Wyse Jackson and Sutherland 2000).

A true botanic garden should also be an educational institution (Byrd 1989; Khoshoo 1987; Wyse Jackson and Sutherland 2000). While this characteristic may spring from the scientific mission of botanic gardens just mentioned, it at the same time pulls these gardens back into the public realm. A botanic garden will make education a primary focus and will use its collections for display and education (Wyse Jackson and Sutherland 2000; Mielcarek 2000). Botanic gardens are important resources in the development of educational programs that encourage people to think more deeply about ecology, plants, and our connection to both (Galbraith 2003). Because of its public face and educational potential, the botanic garden has the opportunity to be an interface between human environments and ecological systems, introducing people to ecology within the confines of a constructed sanctuary (Mozingo 1997). As will be noted, one of the primary educational roles of modern botanic gardens,

according to some, is to teach people about our connection to the ecological systems of the earth in order to promote conservation.

Multiple authors include conservation in their definition of what constitutes a botanic garden (Wyse Jackson and Sutherland 2000; Evans 1999). But is there a definition for a “conservation botanic garden”? In fact, there is, along with a related definition for a different type of conservation garden. The “conservation botanic garden” is one that has developed in response to local plant conservation needs, contains or is associated with areas of natural vegetation in addition to cultivated collections, focuses exclusively on plants native to the region, and engages in public education (Wyse Jackson and Sutherland 2000). Closely related is the “natural or wild garden” containing a protected and managed area of natural or semi-natural vegetation, established to foster conservation and educate the public (Wyse Jackson and Sutherland 2000).

Finally, botanic gardens are also places to experience beauty and to recreate (Mielcarek 2000; Byrd 1989). A botanic garden’s work with plants should not be confined to laboratories and herbariums. Plants should be displayed (Wyse Jackson and Sutherland 2000; Byrd 1989) so that people can appreciate the aesthetic qualities of individual plants and of groups of plants (Byrd 1989; Khoshoo 1987).

In summary, a “botanic garden” is a composite of multiple uses and programs ranging from collections and scientific research to education to recreation (Byrd 1989; Khoshoo 1987; Wyse Jackson and Sutherland 2000; Evans 1999; Mielcarek 2000).

## **QUESTION 2: WHAT PURPOSES HAVE BOTANIC GARDENS SERVED?**

The function or purpose of any garden is a social/cultural construct that is continually changing (Treib 1995). Botanic gardens are much like other gardens and public parks, which are manifestations of the historical ideologies of the time and of the personal ideologies of designers (Taylor 1995). As such, the purposes of botanic gardens have changed and developed over time, typically following the dominant philosophies and needs of specific time periods. Botanic garden design and organization have also changed as necessary to support the institutional purpose of the garden. Therefore, understanding the purposes of historical botanic gardens will give insights into their physical design and lead to a better understanding of modern botanic gardens, which is critical to making wise, effective planning and design decisions.

For example, under the influence of the medieval Catholic church, the philosophical basis of the first western botanic gardens was to re-create the original paradise of Eden, which was believed to have contained everything that God created in the beginning (Prest 1981). Humanity was seeking to re-establish the perfection intended by God but destroyed by man through the Fall (Prest 1981). The forms used in constructing these gardens reflected this purpose. The enclosing wall suggested the original boundaries of Eden and the exclusion from Paradise of a fallen world; the orderly geometric patterns of the planting beds suggested the perfect order of God and that of His original creation (Prest 1981). It is worth noting that the same forms given such strong symbolic meaning from a

religious viewpoint were also very practical ways to meet the secular purposes of a botanic garden.

Two authors, Heywood and Mielcarek, have divided the secular purposes of botanic gardens into five or so distinct categories by date (Heywood 1987; Mielcarek 2000). The dates given by one author do not correlate exactly to those given by the other. However the general time periods and descriptions are similar enough to group them as follows: Group 1 from the mid 1500s to late 1600s; Group 2 from the late 1600s to late 1700s; Group 3 from the late 1700s to mid 1800s; Group 4 from the mid 1800s to the Present; and Group 5 from the mid 1800s to the Present. Mielcarek divides Group 4 into two time periods, while Heywood provides only one. In addition, only Heywood discusses Group 5. These groups will be used here to illustrate historical botanic garden purpose as well as changes in purpose over time. Figure 2-1 presents a timeline of these historical botanic garden groups.

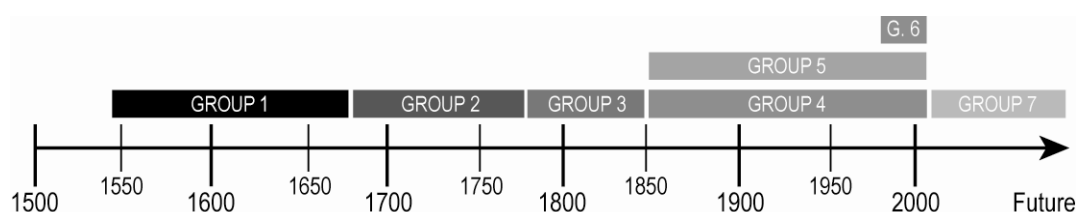


Figure 2-1: Timeline of Botanic Garden Historical Groups

### Groups 1 through 5

Botanic gardens in Group 1 (mid 1500s to late 1600s) have been called European Medicinal gardens (Heywood 1987). They originated in response to a renewed interest in learning and the natural sciences (Wengel 1987). The first



garden recognized as a modern botanic garden pertains to this group, and was founded in Pisa, Italy in 1543 (Heywood 1987). These gardens were established to collect, grow, and display plants for use by medical students (Heywood 1987); to classify plants and determine their usefulness to man (Mielcarek 2000); and to build comprehensive plant collections for scientific study, much like a living encyclopedia (Mielcarek 2000; Prest 1981).

Gardens in Group 2 (late 1600s to late 1700s), termed Classic European botanic gardens (Heywood 1987), continued to identify and taxonomically catalog new plants, seek economic and medicinal uses for plants, and began to work at acclimatizing plants for growth in particular regions (Heywood 1987; Mielcarek 2000).

Gardens in Group 3 (late 1700s to mid 1800s), called Colonial Tropical botanic gardens (Heywood 1987), began to change in purpose from past botanic gardens. They became commercial undertakings intended to provide lumber, fruit, vegetables, and other products with economic potential; and centers for agricultural and horticultural study, including the study of ornamental plants, with a focus on tropical botany (Heywood 1987). They continued their activities in acclimatization and worked to propagate economically valuable plants (Mielcarek 2000). During this period, private botanic gardens, those not connected to a university, began to be established (Mielcarek 2000).

Group 4 (mid 1800s to Present) is characterized by botanic gardens largely founded and sponsored by governments, called Civic and Municipal botanic gardens (Heywood 1987). Founded as university botanic gardens began

to decline, these gardens generally did not have significant scientific or taxonomic programs, they focused more on public education and horticulture than science or research, and they emphasized aesthetics over science and education (Heywood 1987; Mielcarek 2000). They blur the line between botanic and public gardens (Mielcarek 2000).

Group 5 (mid 1800s to Present) contains specialized botanic gardens, called Special Kinds (Heywood 1987). In an atmosphere of increasing generality, some botanic gardens have specialized on a specific area of scientific research. Areas of specialization include agricultural plants, germplasm collections, medicinal plant research, native plants, or a single plant species (Heywood 1987).

### **Group 6 and Group 7**

At this point, it is necessary to address changes in botanic garden purpose over the last 20 to 30 years, and to look into the future. This will be done by adding two groups not found in the literature: Group 6 covering 1980 to the Present, and Group 7 looking to the future.

Group 6 (1980 to Present) contains botanic gardens focusing on education, conservation, research, and public appeal. The detailed descriptions that follow address what botanic gardens today are doing, should be doing, and hope to be doing. The intent is to show not only an ongoing shift in botanic garden purpose, but also a melding of traditional purposes with those of more

recent origin. The challenges and opportunities faced today are much different from those of the 1500s and should be approached differently (Robertson 1989).

***Education.*** The educational role of the botanic garden is a phenomenon of the last few decades, and was slow in coming (Heywood 1987). Currently, the environmental education of the general public through programs and activities is recognized as one of the most important functions of botanic gardens, and perhaps their primary concern (Forero 1985; Boden and Boden 1987; Portico Group 1997; Tankersley and Jones 1999; Wyse Jackson and Sutherland 2000; Mejia 1991). Different authors have suggested that the educational goals in botanic gardens should focus on plant conservation (IUCN 1987; Valdivielso 1987; Wright 1999; Portico Group 1997), ecological systems and sustainability (Wyse Jackson and Sutherland 2000), the interconnectedness of plants and organisms (Hoversten and Jones 2002), and how humans interact with the earth on local and global scales (Hoversten and Jones 2002).

One way of accomplishing these goals is to expose people to plants in a way that instills admiration and respect for nature (Mangenot and Valck 1987; Forero 1991; Portico Group 1997). Another approach is to constructively comment on the relationship between civilization and nature, show that both are part of natural evolution, and show how to integrate the two in positive and sustainable ways (Byrd 1989; Forero 1991; Portico Group 1997; Wyse Jackson and Sutherland 2000; Hoversten and Jones 2002). Botanic gardens should relate their missions and activities to visitors' lives, demonstrating practical knowledge and skills that local people can use—showing them how to apply in their daily

lives what they have learned in the garden to make a difference in the natural world (Mejia 1991; Hoversten and Jones 2002; Jones and Hoversten 2004). A garden's collections should promote a moral message, or advocate specific issues and changes in individual attitudes toward the land (Robertson 1997; Hoversten and Jones 2002; Jones and Hoversten 2004).

**Conservation.** Botanic gardens have a duty and obligation to conserve biodiversity (Wyse Jackson and Sutherland 2000). Conservation is one of the most important functions of botanic gardens, and the principle reason for existence of many (Forero 1985; Hamann 1987; IUCN 1987; Mejia 1991; Evans 1999; Tankersley and Jones 1999; Wyse Jackson and Sutherland 2000; Klemmer and Skelly 2006).

One of the ways botanic gardens can promote conservation and plant diversity is to cultivate native plants and make them the core of their collections (Heywood 1987; Robertson 1997; Wyse Jackson and Sutherland 2000), and then organize their collections at the ecosystem level (Robertson 1997; Portico Group 1997). Other ways botanic gardens can promote conservation include getting involved at the local level and supporting local conservation efforts (Forero 1991); allowing their staff to work on conservation projects (Strick 2006); choosing to protect plant habitats over growing plants in cultivation (Hamann 1987); working to solve specific environmental problems (Cuadros 1991); demonstrating good conservation practices in their infrastructure and facilities (Portico Group 1997); showing the value and beauty of the local region and developing place-specific horticultural knowledge (Robertson 1997); and working

to conserve food and agricultural plants, as well as plants with other economic values (Wyse Jackson and Sutherland 2000).

Ultimately, botanic gardens need to illustrate the importance of plant conservation to the survival of the human race and provoke deeper, holistic thinking about the environment to change humanity's relationship with the earth (Valdivielso 1987; Hoversten and Jones 2002; Galbraith 2003). This can be done by helping people connect with plants and illustrating how plants are used and the value they have to people (Strick 2006; Meilleur 1991; Forero 1991; Robertson 1989).

**Research.** Botanic gardens should conduct and support scientific research (Forero 1985; Byrd 1989; Evans 1999; Tankersley and Jones 1999; Wyse Jackson and Sutherland 2000) and be about more than collecting as many plants as possible (Robertson 1989). They should focus on finding plants with economic or scientific value before they become extinct, conserving plants at risk of becoming extinct, establishing nature reserves, and, if necessary, holding the last living examples of endangered plants (Forero 1985). They should also conduct work in the biological and environmental sciences (Byrd 1989) as well as continue traditional botanical work (Tankersley and Jones 1999) and plant collection (Evans 1999).

**Public appeal.** Efforts to attract the public to botanic gardens over the last century have tended to shift the focus of botanic gardens from science and research to the creation of aesthetic strongholds with an educational bent (Mielcarek 2000). In fact, some botanic gardens make popular appeal a primary

focus of their activities (Kleinman 1997). Whatever potential negative impacts this shift may have on education, conservation, and research in botanic gardens, the public must be accommodated in the garden (Boden and Boden 1987) because visitors are often essential to garden success.

Gardens can foster public appeal through plant collections and displays (Evans 1999; Gates 2006), recreational activities and outdoor events (Portico Group 1997), and practical demonstration gardens (Tankersley and Jones 1999). With proper foresight, the botanic garden can be a cultural resource and attraction, as well as a tourist destination (Portico Group 1997; Parman 1999) introducing both locals and visitors to the beauty of the region and its native vegetation (Heffernan 2006; Strick 2006). However, to truly connect with the community, botanic gardens should begin to dissolve their borders, and instead of being a separate, walled place, become part of the community and the surrounding landscape (Fromme 2006).

Group 7 (Present into the Future), unlike the other groups, does not describe a category of garden. It simply presents suggestions for future botanic gardens. In the future, botanic gardens should present nature as a whole, interconnected with people, and full of wonder (Robertson 1997). To accomplish this, five types of plant collections are suggested as necessary for future botanic gardens: (1) Native Plants, (2) Ecological and Bio-geographic, (3) Taxonomic, (4) Adaptive Lifestyle and Experiential, and (5) Reclamation and Genetic Conservation (Robertson 1997). Each is explained below (Robertson 1997).

(1) Native plant collections should be included to show off their beauty and value. Such collections also provide the opportunity to educate visitors about complete living systems.

(2) Ecological and Bio-Geographic collections both show the range of habitats in a defined area but at different scales. Ecological collections focus on the local area or region. Bio-geographic collections attempt to re-create ecosystems from another part of the world.

(3) Taxonomic collections continue to have value in their ability to showcase the overwhelming diversity of plant life and emphasize the necessity of each piece in the puzzle.

(4) Adaptive Lifestyle and Experiential collections, also called demonstration gardens, portray and promote a particular lifestyle or sense of place.

(5) Reclamation and Genetic Conservation collections should exist to research and demonstrate reclamation and conservation methods that could be applied in the local environment.

The future of public and botanic gardens in any community lies in their becoming an integral part of people's daily routines (Fromme 2006). To do so, individual gardens will likely have multiple roles (Wyse Jackson and Sutherland 2000). However, each garden must take care to not dilute its message(s) by attempting to do too much (Robertson 1997). Just as the founders of the first botanic gardens were seeking to re-create paradise (Prest 1981), modern and

future botanic gardens must ask, what kind of paradise should the human race be aspiring to now (Robertson 1989)?

## **Conclusion**

It is clear that the purposes of botanic gardens have reflected the attitudes and needs of society at the time. During the 1500s, botanic gardens reflected the need for medicines, an awakening interest in the natural sciences, and religious ideals that still influenced people's actions. The purposes of modern botanic gardens, both suggested and applied, are no different. The emphasis on conservation reflects humanity's concerns for the state of the natural world and the overall environment. The emphasis on education is a reaction to the need to make known the plight of the environment and what we can and need to do about it.

Whatever their current or future purposes, botanic gardens have made and continue to make significant contributions to society, including the development of taxonomic and experimental botany, the identification of plants with economic value, and the provision of horticultural services such as hybridization and distribution (Mielcarek 2000). However, above all other purposes a botanic garden may have, it is essential to remember that the botanic garden, like other gardens, is for people (Fromme 2006).



### QUESTION 3: WHAT PLANNING AND DESIGN PRINCIPLES AND FORMS WERE HISTORICALLY USED IN BOTANIC GARDENS, AND WHAT PURPOSES DID THEY SERVE?

The planning and design elements of the first botanic gardens have been well-documented in other places (Prest 1981), as have the planning and design elements of botanic gardens between then and now. The purpose here is not to recount the history of botanic garden design, but to highlight the major design elements and show how they served garden purposes of the time. The groups and temporal divisions introduced in the previous section will serve as the basis for this purpose/design comparison. Figure 2-1 illustrates these divisions.

#### **Group 1: European Medicinal (mid-1500s to late 1600s)**

*Group Synopsis: Medicinal. Facilitate learning. Collect, grow, and display plants for use by medical students. Classify plants and determine their usefulness. Build comprehensive, referenced plant collections for scientific study, like an encyclopedia.*

The design of botanic gardens during this period was characterized by functionality and organization. The *hortus conclusus* form was adopted to create a place of contemplation separate from the world (Prest 1981). The ideal shape for a garden was considered to be the circle, possibly due to the circle's religious symbolism (Prest 1981). However, the main area of most gardens was typically a square (Prest 1981), as demonstrated in the gardens at Padua (Mielcarek 2000) and Oxford (Prest 1981). This main square was divided into quarters, reflecting

thousands of years of garden design (Prest 1981; Mielcarek 2000). After the discovery of the American Continent, each quarter came to represent one of the four known continents (Prest 1981; Mielcarek 2000), thus adapting old forms to new uses. The quarters were subdivided into planting beds called parterres or pulvilli (Prest 1981; Mielcarek 2000). Parterres were built in intricate geometric patterns, while the pulvilli were long, straight, and narrow (Prest 1981). The beds were carefully organized and numbered, to facilitate locating and studying the plants (Prest 1981). Often, plants from a single family were placed in the same bed (Prest 1981). All beds were narrow enough that every plant in them was accessible from the paths adjoining each side (Prest 1981), a functional layout feature common in medieval herb gardens (Huxley 1978).

Not all early botanic gardens followed this pattern exactly. The Jardin du Roi made an early attempt to respect and provide the micro-climatic needs of plants, and included habitats in its design, with ravines and hills, meadow, and marsh (Prest 1981; Mielcarek 2000).

In summary, the purpose of the enclosing wall was to shut out the blemished world, both natural and man-made, in order to contemplate higher things (Prest 1981). The subdivided and numbered beds were designed to index plants in the collection for study (Prest 1981). The designs combined aesthetics with scientific functionality. The geometric patterns and formal lines in these gardens were influenced by Renaissance ideals, which represented the prevailing cultural, scientific, and aesthetic thought of the time (Byrd 1989). At least one attempt was made to represent habitats.

**Group 2: Classic European  
(late 1600s to late 1700s)**

*Group Synopsis: Continue taxonomic classification of newly discovered plants. Seek economic and medicinal uses. Acclimatize Plants.*

The basic formal elements used in botanic gardens during the previous 100-plus years largely continued during this period (Mielcarek 2000). However, the manner in which collections were organized changed. The Linnaean classification system, introduced toward the end of this period (around 1753), began to influence the organization of plant collections (Byrd 1989). While a strong formal style did not accompany this change, the change did provide a basis for different spatial patterns in the garden (Tamutyte 2006) and may have weakened the position of the quartered square as a dominant design element. The original physic garden at Kew is said to have displayed its plants in long rows, organized according to the Linnaean classification system (Evans 1999), but no mention is made of the overall structure of the garden.

During this time, two other plant organization methods began to develop, the physical appearance of which would have varied significantly from the geometry and order of earlier botanic gardens. The first was based on re-creating habitats and placing plants in their correct habitat (Byrd 1989). The second focused solely on aesthetic arrangements and tried to re-create complete garden styles, such as the Japanese garden (Byrd 1989).

In the late 1700s at Kew, possibly reflecting circumstances at other gardens, climate-control structures for exotic plants were added, and pleasure

grounds began to make up an extensive part of the garden property (Evans 1999).

In summary, the philosophies underlying the organization of a garden had definite formal manifestations. The system used to classify plants had an impact on how garden collections were arranged. Changing attitudes toward nature resulted in new organizational and design elements. The importance of aesthetics increased.

### **Group 3: Colonial Tropical (late 1700s to mid 1800s)**

*Group Synopsis: Commercial. Provide lumber, food, and other economic products. Conduct agricultural and horticultural studies. Focus on tropical botany. Propagate and acclimatize plants. Non-university gardens are established.*

During this period, the mission of the botanic garden shifted toward a more commercial and economic role, while still pursuing collections and other scientific work. Little was found in the literature about the design elements of these colonial and commercial botanic gardens. However, information was found about more general botanic garden design changes, and examples from specific gardens of the period are generalized here.

Botanic gardens during this period had to increase in size to accommodate the large numbers of plants being discovered around the world (Byrd 1989). As botanic gardens' need for space increased, so did their need for public support, and they began to cater to a wider public through aesthetic, park-like design, because a greater percentage of the public was interested in beauty

than in horticultural science (Byrd 1989; Lighty 1989). This coincided with the rise of public pleasure grounds and the growing influence of Frederick Law Olmsted, Sr.; two factors which helped shift the design of botanic gardens from emphasizing science to emphasizing aesthetics (Lighty 1989). Design and organization became much less encyclopedic. Elements such as serpentine paths and mounds, and considerations such as views and the perceived size of the grounds, began to influence garden structure (Taylor 1995).

During this period, the work of Olmsted, Sr. showed that taxonomic, habitat, and aesthetic principles could be successfully combined (Byrd 1989). The designers of Kew gardens used tree-lined views and secluded glades to provide scale and unity to the gardens' collections, again showing that science and aesthetics could be combined (Evans 1999).

Specific aesthetic elements became important, such as the display characteristics of individual plants, and how and where to display them to best effect (Taylor 1995). The glasshouse as a decorative, climate-controlled structure for the display of exotic plants became a central feature of many botanic gardens (Taylor 1995). The display of plants in their natural habitats became more common as well (Byrd 1989).

Taxonomic design, in which plants were arranged according to some taxonomic classification system, was common during this period (Medbury 1991). Plants in the collection were arranged and planted along paths in such a way that visitors were introduced to the plants in taxonomic sequence (Medbury 1991). Individual plants were spaced according to gardenesque principles, so that each

was a specimen, with enough room to grow without touching other plants (Medbury 1991). In the Derby Arboretum, the collections were arranged around the circulation system, which was laid out so that a visitor could see the entire collection without ever retracing a step (Medbury 1991).

During the 1840s, large beds of colorful flowers in carefully designed patterns became very popular in English public parks and were used to grab the attention of the general public (Taylor 1995). This trend carried over into at least one major botanic garden, that at Kew, as a result of governmental desire to provide amenity for the public (Evans 1999).

In summary, displaying plants in natural-appearing habitats became more common. Due to factors such as increasing size, government ownership, and the need to garner public support, botanic gardens began to give more attention to aesthetics and the visitor experience than to scientific collections and research. The display of collections became an important consideration in garden design. Aesthetics used in botanic gardens followed the dominant landscape design philosophies of the day.

#### **Group 4: Civic and Municipal (mid 1800s to Present)**

*Group Synopsis: Focus on public education and horticulture. Provide a stronger aesthetic experience for visitors. Conduct less scientific work, taxonomy, and research. The line between botanic garden and public garden begins to blur.*

In the realm of design, this period seems to largely be a continuation of trends from the previous period, and the line between scientific botanic garden

and public garden becomes more blurred. Much of the literature focuses on arboretums and public parks with an arboretum component. Again, examples from specific gardens are generalized here.

In attempts to re-create segments of nature, designers during this period, such as Paxton, attempted to represent rocks, cliffs, and other features of nature in addition to plants, and to include elements of natural history (Taylor 1995). Public parks were intended as outdoor stage sets designed to facilitate pre-determined visitor responses (Taylor 1995). Designers used vegetation and topography to frame views, separate uses, and connect with the surrounding landscape (Taylor 1995).

As in previous periods, topography was created to provide suitable micro-climates for certain plants (Evans 1999). The spottiness of the gardenesque style was seen in some instances as inferior to the display of multiples of a species or plants in large groups (Medbury 1991). Taxonomically-based plant organization and displays continued to be used in gardens such as the Central Park arboretum and the Arnold Arboretum (Medbury 1991). However, even taxonomic displays were designed to appear picturesque, and attention was given to placing the plants in the most favorable growing conditions (Medbury 1991). Recognizing the improbability of creating a comprehensive plant collection, a design proposed for the Missouri Botanical Garden was taxonomically based but would have presented a synopsis of representative species from a family or genus, instead of trying to include every species (Medbury 1991).

After the 1930s, botanic gardens no longer used taxonomic arrangements in their plant collections (Medbury 1991). Instead, they were designed to display plants and collections geographically, ecologically, or with a focus on aesthetics, and often in combinations of all three (Medbury 1991).

In summary, attempts to re-create nature included geologic features as well as plants and habitats. Designers of public outdoor spaces attempted to provide a pre-determined experience for visitors. Particular spatial qualities were carefully considered and included in garden design. Plants were organized in groups and massings, although sometimes still in taxonomic arrangements. The requirements of individual plants were considered in placement and design. The idea of representing habitats with representative species was introduced. Taxonomic arrangement, in use for over 300 years, gave way to other methods of organization and display.

#### **Group 5: Special Kinds (mid 1800s to Present)**

*Group Synopsis: Focus on a specific area of research.*

No design precedents specific to specialized botanic gardens were found in the literature.

### **QUESTION 4: WHAT DESIGN PRINCIPLES AND FORMS HAVE BEEN USED IN BOTANIC GARDENS OVER THE LAST 20 TO 30 YEARS?**

The actions of modern botanic gardens over the past 20 to 30 years give some indication of the current state of botanic garden purpose and design. They



provide a viewpoint from which to examine current design, determine if it differs from historical design practices, and decide if there is a need for change in the future.

The information presented in this section was taken from written descriptions of garden implementations or final plans, not from illustrative plans or drawings. Little of it was part of specific discussions on botanic garden design. Some was inferred from comments and descriptions. It is hoped that this approach will both identify design elements and provide some understanding of the purposes behind them. The categories used to organize the elements are based on similarities found in the references, not on any formal system.

### **Visitor Amenities**

The garden and its facilities have a visitor-centered layout (Greenhouse and Socolofsky 1997), are universally accessible (Portico Group 1997), and safely and adequately accommodate both visitor needs and the needs of the garden and its staff (PBR Hawaii 2002). For visitor convenience, structures are clustered in the most accessible areas of the site (Portico Group 1997). Seating is protected from the local elements, with shade provided in hot climates and sunny exposures provided in cooler climates (Greenhouse and Socolofsky 1997). Appropriate refreshment is provided, such as regularly distributed drinking fountains (Greenhouse and Socolofsky 1997). Some gardens seek to create a place of comfort and beauty that is an oasis in an urban setting (PBR Hawaii 2002).

## **Garden Structure**

Structural elements are those that help organize the garden's collections and displays and that help define the visitor's cognitive perception of the garden. Aesthetics, horticultural roles, and scientific roles are integrated into the design solution (Portico Group 1997). Trails are designed as loops so that the visitor never has to worry about missing something if a particular turn is taken (Greenhouse and Socolofsky 1997; Portico Group 1997). Trail hierarchies with main and secondary trails, distinguished with different paving treatments, aid visitor navigation (Greenhouse and Socolofsky 1997). Trails are designed to connect the entrance and visitor facilities to all areas of the garden and to allow use by trams as well as pedestrians (Portico Group 1997). Directional signs are consistent in wording and style and are installed at decision points, and identification signs are installed at all destinations (Greenhouse and Socolofsky 1997).

Open space, such as large areas of lawn, is used as a framework to tie together the more detailed, thematic collections (Byrd 1989) and to set them apart through contrast (Mangenot and Valck 1987). For example, the formality of a Renaissance garden is heightened when contrasted with informal open areas or the densely-planted interior of a glasshouse (Evans 1999). This contrast also highlights the formal garden as a destination. Adequate open space produces park-like settings for botanically-organized and ornamental collections (Watson 1997).

## **Collections Organization and Display**

Collections are organized and displayed in a variety of ways in modern botanic gardens. Some ways are traditional and others have developed more recently. Each has its own physical manifestation. Some gardens organize their collections to create a setting that is aesthetically pleasing and beautiful overall (Portico Group 1997; Morton Arboretum 2006), with displays that highlight seasonal plant qualities (Portico Group 1997) and that are more naturalistic than formal (Evans 1999).

Other examples of organization and display include plants organized on a geographical map according to their geographic origin (Mangenot and Valck 1987) and plants organized in the shape of a genealogical tree and ordered from most primitive to most developed (Mangenot and Valck 1987). In one garden, the collections are organized according to a linear, taxonomic classification method (Byrd 1989). Another has the plantings around its perimeter arranged according to an evolutionary taxonomic system, placed in order with the more primitive plants at one end and the most advanced on the other (Byrd 1989). In a more general vein, a third is said to place its woody plants according to botanical themes (Watson 1997).

It is worth noting that at least one author has said that a sequential taxonomic approach to botanic garden design is unlikely to meet the diverse needs of today's botanic gardens (Medbury 1991).

## **Conservation Design**

A number of valuable precedents, summarized here, were found on the topic of conservation design in botanic gardens. At least one botanic garden is located in a natural habitat (Valdivielso 1987). Forested linkages within another garden were restored, and areas of native vegetation are allowed to grow unchecked and uncultivated to demonstrate desirable habitat (Watson 1997).

Collections are displayed in authentic regional ecological communities and patterns found in nature (Wott 1999; Portico Group 1997; Brzuszek and Clark 2007). Region-specific plant communities and ecosystems are represented through re-created signature landscapes, those most likely to evoke the feeling of the place represented (Portico Group 1997). Certain natural features of the regional landscape are highlighted in the garden (Brzuszek and Clark 2007). Ecosystems are organized along paths, each of which focuses on a specific ecosystem (McIntyre 2006).

Gardens focus on the culture and display of regional native plants (Simmons 2002) and the paths are organized to introduce the native vegetation (Valdivielso 1987). Native plants are used to portray the local regional landscape character, as opposed to that of another part of the world (Brzuszek and Clark 2007). Native plants are grouped in communities and placed in the garden at locations that provide appropriate micro-climatic conditions (Brzuszek and Clark 2007).

Sustainable design principles were used to develop self-maintaining natural and cultural systems (Portico Group 1997). Facilities are constructed to

be water- and energy-efficient and to use sustainable building principles and techniques (Portico Group 1997). From a higher-level point of view, all planning and design decisions are made cognizant of the fact that every choice will have an impact on local, regional, and global natural and cultural resources (Portico Group 1997).

### **Education Design**

Education is a major component in many modern botanic gardens, and educational goals have been met through a variety of means. For example, garden staff and volunteers have collaborated on the design of interpretive exhibits to provide as many different viewpoints as possible (Greenhouse and Socolofsky 1997). A garden's interpretive story and message are integrated into the physical infrastructure (Portico Group 1997) and used to tie the garden together (Gray 2006). To promote a garden's message of sustainability, facilities are designed to be water- and energy-efficient and are built using historical techniques and alternative materials (Portico Group 1997).

Gardens provide educational facilities such as an exhibition hall, permanent educational displays, laboratory space, classrooms (Valdivielso 1987; Morton Arboretum 2006) and an amphitheater (Portico Group 1997). Well-designed, functional, and attractive demonstration gardens are included (Wott 1999; Portico Group 1997). Interpretive walks are used to introduce and explain a topic or story (Gray 2006; McIntyre 2006). Plants and people are brought closer together through interpretation and physical proximity in design (Morton

Arboretum 2006). Stations are provided throughout a garden where visitors have the opportunity to handle plants and ask questions of staff and informed volunteers (Greenhouse and Socolofsky 1997).

The elements of aesthetics, horticulture, and science are integrated and applied in natural and urban landscapes to maximize their impact on visitors (Portico Group 1997).

### **Design Process**

In deciding which design decisions to make and how to make them, botanic gardens have used diverse methods, with most using a combination of methods. Some have used other botanic gardens as precedents, inspiration, and benchmarks (PBR Hawaii 2002; Mangenot and Valck 1987). Some have looked to the past and replicated historical ideas and patterns (Vandiver 1991). At least one has used the major phases of botanical and garden history to guide the layout of the garden (Byrd 1989).

Some use their mission statement and purpose to guide planning and design at all levels (Wott 1999). Others allow the natural features of the site and those surrounding the site to guide the design (Byrd 1989). For example, site features such as natural drainages are integrated as water features (Portico Group 1997). Existing on-site vegetation is incorporated into the design and allowed to grow without interference (Watson 1997).

Other gardens hire professionals to help in design, interpretation, planning, and programming (Greenhouse and Socolofsky 1997). Some rely on

visitor questionnaires and staff observations of visitor behavior (Greenhouse and Socolofsky 1997).

## **Summary**

In summary, recent botanic gardens utilize a variety of design methods and styles. Many of these methods and styles do not differ from historical practices. Some organizational and collections practices are of recent development, or have been refined in recent decades in response to changing attitudes toward the environment, a better understanding of natural science, and changing perceptions of botanic garden purpose. However, even some gardens claiming to be focused on the currently relevant mission of conservation use standard design practices with long histories in the garden.

### **QUESTION 5: WHAT DESIGN GUIDELINES HAVE BEEN SUGGESTED, OR MIGHT BE INFERRED, FOR MODERN BOTANIC GARDENS IN THE RELEVANT LITERATURE?**

This summary of published design guidelines represents ideas both explicitly stated in and inferred from the literature, and that may have been presented as general guidelines or as guidelines for specific projects. They cover many aspects of design, but often on a general level, and are not comprehensive.

## **Purpose/Design**

How do purpose and design relate in the botanic garden? The literature reveals that the botanic garden's design should be based on institutional goals and objectives (Byrd 1989) and should reinforce the garden's mission (Hoversten and Jones 2002). Main messages should be identified before any design decisions are made (Parman 1999). Everything from spatial divisions in the garden (Leadlay and Greene 1998) to the layout of collections and program elements should support the mission statement (Byrd 1989). The fact that garden design has historically changed to reflect dominant ideologies (Cohen 2007) supports the need to let it be guided by purpose. Assuming that science is one of the purposes of a botanic garden, art and science must merge on garden grounds because art can be the interface through which the public approaches and begins to understand science (Byrd 1989).

## **Design Process**

The design process for a botanic garden should ideally begin when the idea for the garden first germinates, and continue through to implementation and maintenance. The literature outlines in some detail effective design processes for a botanic garden. Some mention the need for a master plan (Mielcarek 2000; Portico Group 1997). But the master plan does not represent the entire design process, and when the time comes to implement it, there are many ways to arrive at appropriate design solutions (Scarfone 1999). Throughout the process, those



in charge should use the expertise of staff and volunteers to solicit as many different opinions as possible (Greenhouse and Socolofsky 1997; Parman 1999).

If the goal is to develop a botanic garden focused on conservation, its purpose should be justified before the design process begins. Specifically, the garden should have an ecological justification, the relative ecological value of its proposed collections should be evaluated, and its future management and longevity should be planned out (Mejia 1991).

Typically, step one in the design and planning process is to develop a mission and/or purpose statement, which should guide all subsequent decisions (Rakow 2006b; Robertson 1989; Leadlay and Greene 1998; Wyse Jackson 2003). Step two is to conduct a detailed site analysis and inventory (Leadlay and Greene 1998; Wyse Jackson 2003). Site features identified during this process should influence and be integrated into the design (Leadlay and Greene 1998; Wyse Jackson 2003). Alternatively, some say that the site should actually determine the mission, instead of being forced to accommodate a pre-determined mission (Leadlay and Greene 1998). This being the case, step one would be to analyze and inventory the site to determine what the mission should or could be. Step two would then be the development of a mission statement. Step three, in either case, is to develop a list of desired program elements that support the mission statement, including natural features, man-made features, and planned programs and activities (Leadlay and Greene 1998; Wyse Jackson 2003). Infrastructure necessary to support the mission could also be determined at this point (Wyse Jackson 2003). Step four is to develop a concept plan for the

garden (Wyse Jackson 2003). Step five is to develop a master plan with the help of qualified professionals that reflects the natural and cultural contexts of the garden, responds to the site's unique characteristics, fulfills the objectives of the mission statement, accounts for all program elements, includes all buildings, is guided by the desired collections plan, and anticipates change (Byrd 1989; Mielcarek 2000; Leadlay and Greene 1998; Wott 1999). The master planning process should be the vehicle for examining alternative designs (Wyse Jackson 2003). Step six is to develop a graphical site plan that illustrates the master plan and shows how the garden relates to its surroundings, how visitors will arrive at the garden, and what spatial divisions will exist within the garden (Leadlay and Greene 1998). Finally, a written document that explains phasing and design guidelines should be prepared to accompany the master plan (Scarfone 1999).

The purpose of the master plan is to guide the physical development of the garden (Mielcarek 2000). It should be a temporary document that is flexible enough to anticipate and adapt to new programs, future needs, and future changes and modifications (Fromme 2006; Scarfone 1999). It should address current and future visitor needs (Fromme 2006; Benfield 1999), current and future collections (Wott 1999), and site features and conditions (Leadlay and Greene 1998). The master plan should, as should any idea related to the garden, conform to all aspects of the garden's mission statement (Rakow 2006b); provide a practical, phased implementation schedule based on the resources available for construction (Rakow 2006b; Wyse Jackson 2003; Mielcarek 2000; Mitchell

2002); and facilitate maintenance and repairs (Mitchell 2002). It should be reviewed regularly and updated every five to ten years (Mielcarek 2000).

The master plan cannot, however, spell out all issues related to design. It is largely a process document. Even the best design process will only help ensure that the right questions get asked; it will not give the right answers (Gray 2006). Therefore, more specific guidelines are needed, and are found in the literature.

All design decisions should accommodate the garden's site, its mission, and its program (Scarfone 1999). To guide design decisions, a narrative can be developed that describes what the visitor should experience and learn between the entrance and the exit (Parman 1999). Ultimately, design should orchestrate the people, plants, and spaces that will together create the garden experience (Fromme 2006).

When deciding on patterns and forms, garden designers should look to current aesthetics, current social patterns, and the current status of scientific knowledge, while remembering that trifling, trendy implementations of each soon fall out of fashion (Byrd 1989). They can import garden ideas and styles from other places (Treib 1995). Designers can build on the experience and examples of other botanic gardens (Parman 1999). However, they should not automatically use standardized designs and programs, but remember that each botanic garden should be original and unique (Byrd 1989). Designers should use historic landscape examples and design principles only if they are relevant to current goals and purposes (Taylor 1995).

It can be a good idea to break up the detailed design of the garden into phases and small areas and not attempt to design the entire garden at one time (Scarfone 1999). Visitor focus groups can be used to guide plans and designs (Parman 1999). Thought should be given to devising ways to get visitors to linger in the garden (Rakow 2006b). Designers should remember that design is a matter of opinion, and design done by a single individual is often more focused and coherent than design done by a group (Gray 2006; Evans 1999).

### **Garden Structure**

Structure in this context refers to the physical and conceptual organization of the garden. It includes infrastructure and trails, how collections relate to one another, visitor way finding within the garden, and cognitive map development. The literature provided a multitude of guidelines in this area. This section will attempt to summarize them.

First, use the cultural and physical context of the garden to guide spatial patterns and the arrangement of facilities (Leadlay and Greene 1998). Spaces should reflect local cultural perceptions (Leadlay and Greene 1998). The design of the garden should respond to the spirit of the place, or *genius loci*, and be uniquely appropriate to the site (Wyse Jackson 2003; Byrd 1989). It may not be too strong to say that the site and its existing qualities should dictate garden structure (Scarfone 1999). The spaces in the garden should be varied in purpose (Cohen 2007); should mix intimate space, broad open expanses, and views (Portico Group 1997); and should be in scale with the size of the garden (Mitchell

2002; Leadlay and Greene 1998). In designing spaces with plants, it should be remembered that the quality of the space will change with the seasons and the passing of time (Mitchell 2002).

Second, ensure that all areas of the garden, from a design point of view, seem to belong to the same institution (Rakow 2006b), tied together by some unifying element (Robertson 1997). Examples of unifying elements include sequential displays, the standardization of hardscape materials, the use of clear navigational cues (Rakow 2006b), and the consistent use of one or more standardized color palettes (Mitchell 2002). Limiting the number of programs and messages can also facilitate unity (Robertson 1997), as can maintaining a consistent scale among garden elements in keeping with the size of the garden (Leadlay and Greene 1998).

Third, use signage to enhance garden unity. At least five types of signs can be employed in a garden: directional, informational/interpretive, place marking, identification, and display (Mitchell 2002). As sometimes the only human element in an otherwise natural setting, signage has a large impact on the visitor's image of the garden (Mitchell 2002) and should be consistent in style and color (Greenhouse and Socolofsky 1997). Directional signs should be placed at all decision points, and identification signs placed at all destinations or exhibits (Greenhouse and Socolofsky 1997). Universal design symbols, such as for restrooms or restricted areas, should be used as appropriate (Mitchell 2002).

Fourth, design trails to enhance navigation, unity, and structure. Trails will have a large impact on the visitor experience. In trail design, include some type

of hierarchy in the trail system (Leadlay and Greene 1998; Portico Group 1997).

The hierarchy can be based on trail size, surfacing, or traffic (Leadlay and Greene 1998; Portico Group 1997). The surfacing of primary trails should be accessible to wheelchairs (Portico Group 1997). Design trails as loops so the visitor always begins and ends in the same place (Greenhouse and Socolofsky 1997). Give names to trails to help visitors remember where they are (Greenhouse and Socolofsky 1997). The design of the trail system should reflect the garden's size and provide required access to the collections (Leadlay and Greene 1998). At the entrance, pedestrian/automobile conflicts should be minimized (Leadlay and Greene 1998).

Fifth, separate uses within the garden. A number of sources, some of them cited here, referred to the need to separate visitors from behind-the-scenes uses. Some research activities and facilities should be hidden from the public (Robertson 1989; Leadlay and Greene 1998). The garden's nurseries and work areas should be set apart from public areas of the garden (Leadlay and Greene 1998). Pedestrian traffic should be separated from vehicular traffic and from service traffic (Gray 2006). Visitor entrances should be separated from service entrances, and these two user groups should be separated as much as possible within the garden (Leadlay and Greene 1998). Topography, plantings, structures, and trail alignments should be used to achieve this separation (Leadlay and Greene 1998).

Sixth, pay careful attention to the overall experience in the garden because this is what most visitors will take away with them. The botanic garden

should provide an immersive experience for its visitors (Hoversten and Jones 2002), one that makes them think the garden is another world (Gray 2006) set apart from its immediate surroundings (Leadlay and Greene 1998). Design should contribute to this goal by orchestrating a sequence of experiences in time and space, by providing unexpected discoveries, and by providing places of refuge (Fromme 2006).

Seventh, use garden structure to create and screen views. The garden should open views to the surrounding landscape (Leadlay and Greene 1998); screen unpleasant elements in the surrounding landscape (Leadlay and Greene 1998); provide alternative attractive views (Leadlay and Greene 1998); and create open spaces, such as meadows, for visitor enjoyment (Lindemann-Matthies and Bose 2007). Displays in need of higher design and detail should be concentrated around the garden's entrance (Portico Group 1997). Destinations should be created throughout the garden to draw people through (Portico Group 1997).

Eighth, use garden structure to accommodate visitor needs and comforts, starting with the arrival area and parking. Provide clear lines of sight at vehicular entrances and intersections (Leadlay and Greene 1998). Provide more parking than is expected to be necessary (Leadlay and Greene 1998). Where night uses may occur, provide appropriate lighting (Mitchell 2002).

## **Conservation Design**

Conservation design refers to plans and physical implementations intended to protect natural ecological systems, along with their component parts, as well as demonstrate them to visitors within the confines of the botanic garden. Conservation design guidelines in botanic gardens cover elements ranging from representative habitats to native plants. They may apply to non-native plants and systems as well as to native regional systems.

First, the garden as an institution should be appropriate to the local and regional context (Wyse Jackson and Sutherland 2000) and recognize that all decisions made within the garden have local, regional, and global impacts (Portico Group 1997). Botanic gardens are an ideal place to showcase native regional vegetation and create a regional identity (Strick 2006). They should design their collections to include regionally appropriate plants (Robertson 1989). Native vegetation should be displayed in natural systems and patterns, to highlight the unique character of the region, and not as specimens (Robertson 1997). If necessary, abstractions should be used to represent natural systems (Byrd 1989; Cohen 2007). Considering the amount of biodiversity worldwide, no two botanic gardens should be similar in appearance or design (Robertson 1989). Designers should go through a process of give and take to implement design ideals on a specific site under local environmental conditions (Treib 1995).

Second, any garden with a conservation message should present entire natural habitats or make habitats the basis for the overall garden plan (Leadlay



and Greene 1998; Byrd 1989). Existing site features such as topography, aspects, soils, and geology should be respected and leveraged in the design, and existing vegetation should be preserved (Portico Group 1997). Areas should be provided where the regular changes of nature are allowed to take place (Byrd 1989). Based on the site's topography and microclimates, habitat displays should be located in the garden in conditions similar to where they would be found in nature (Leadlay and Greene 1998; Byrd 1989). This should be balanced, however, with the needs of the garden's intended audiences and the collections' intended uses (Rakow 2006b). For example, consideration should be given to relocating a display that is located correctly from a topographic point of view but is inaccessible to garden visitors.

### **Education Design**

A variety of guidelines are provided as to how botanic gardens can educate visitors. To begin, they should use interpretive displays and exhibits (Wyse Jackson and Sutherland 2000; Portico Group 1997; Vandiver 1991). These exhibits should provide the background information that makes the real spaces of the garden and its displays comprehensible (Vandiver 1991). Regarding displays, the garden's plants should be grouped according to taxonomic or ecosystem relationships so visitors can see that plants are part of bigger systems (Hoversten and Jones 2002). To turn abstract theory into practical knowledge, opportunities and facilities should be provided for safe hands-on and sensory experiences with plants (Klemmer and Skelly 2006;

Forero 1991; Cohen 2007; Byrd 1989; Greenhouse and Socolofsky 1997).

Contrasts, such as the many differences between exotic plants and native plants, should be used to clarify educational concepts (Byrd 1989). Special areas and collections should be provided to meet the needs of specific educational courses (Rakow 2006a). Art and design should be used to help the public interface with the science presented in the garden (Byrd 1989). Visitors should be allowed to learn at their own pace (Hoversten and Jones 2002).

Gardens should also use their expertise with their own collections to teach some part of plant conservation (Strick 2006). They should use their collections to show the connections between humans, plants, and animals (Byrd 1989). They should provide examples of how development can co-exist with healthy natural systems (Byrd 1989; Forero 1991). Ways of doing this include functioning agroforestry projects or the sustainable cultivation of native plants with economic potential (Forero 1991). Gardens should use the beauty of ecosystem displays to give people an experience instead of a lesson, and allow the site to tell its own story (Gray 2006). Displays of local cultural traditions, natural systems, and site conditions should be created (Byrd 1989).

### **Collections Organization and Display**

All gardens should develop a detailed collections policy to guide the acquisition and organization of plant specimens (Rakow 2006b; Gates 2006). The quantity, quality, health, and display of a garden's collections will contribute to the unique experience provided by that garden (Gates 2006). Collections

should be laid out according to a careful plan that avoids an experiential smorgasbord in which elements do not relate to one another (Byrd 1989).

Native plants should be displayed in preserved or re-created natural habitats that show the structural and spatial patterns found in nature (Leadlay and Greene 1998; Hitchmough and Dunnett 2004). Doing so can further emphasize a garden's uniqueness (Leadlay and Greene 1998). Where possible, plant collections should be displayed as complete, functioning ecosystems (Robertson 1997) which should be as authentic as possible (Hamann 1987). In support of these guidelines to create authentic displays, at least one study seems to indicate that people are more attracted to species-rich vegetation than to vegetation with limited variety (Lindemann-Matthies and Bose 2007).

Native plants should also be displayed in attractive, functional, non-natural landscapes (Peixoto 1991) because some natives can be as ornamental in a cultivated situation as more traditional exotics (Strick 2006). However, in a conservation garden, the presentation of specimen plants should have a very small role (Hamann 1987). Where appropriate, plantings should be used for dual functional and informational purposes, such as demonstrating street tree applications in the garden's parking lot (Byrd 1989).

One author suggests a way to combine native and exotic plants to highlight differences. The suggestion is to create a gradation with reconstructed native vegetation communities at one end and display gardens with exotic plants at the other (Leadlay and Greene 1998). Between the two extremes, native and exotic vegetation can be mixed or blended (Leadlay and Greene 1998), and, by

inference, natives can be displayed in cultured situations. Another author suggests that non-native plants could be arranged in natural orders and native plants arranged in non-natural orders (Treib 1995). In a conservation situation, previously disturbed areas in the garden could be used to display non-invasive exotics (Leadlay and Greene 1998). Also, the designed collections could be located in the garden's interior and the natural, or native, areas along the outside edges (Leadlay and Greene 1998).

Perhaps above all, the collections and displays in a botanic garden need to be well-designed and attractive (Robertson 1989; Khoshoo 1987) but with careful attention to cultural perceptions of plants and aesthetics in general (Hitchmough and Dunnett 2004).

## **Facilities**

Facilities selected for inclusion in a botanic garden, like any other ideas, should be filtered through the garden's mission statement (Rakow 2006b). Gardens should provide facilities for the scientific study of living collections (Heywood 1987). Because comfortable visitors are more likely to linger, gardens should also provide facilities for visitor comfort such as adequate parking, restrooms, shade, navigation, refreshments, trash bins, and lighting (Rakow 2006b).

When considering what amenities to include in the garden, garden planners should consider the results of one survey of garden visitors. It found that over two-thirds of garden visitors spent time in the gift shop, if provided, but

less than half visited the café, if provided (Benfield 2006). Such investments should be carefully evaluated.

### **Visitor Amenities**

In this section, visitor amenities refer to all aspects of the visitor experience, and focus on the quality of facilities as opposed to the kinds of facilities needed.

To begin, visitor access to the garden should be as easy as possible and should include public transportation (Leadlay and Greene 1998). The entrance gate should facilitate the monitoring of incoming and outgoing visitors (Leadlay and Greene 1998). The area just inside the gate, the arrival courtyard, should provide enough room to accommodate large groups, surfacing that is durable and safe, shelter and protection from the elements, seating and refreshment, waste containers, restrooms, a map of the garden for orientation, the garden's mission statement, and an outdoor educational venue (Leadlay and Greene 1998).

Inside the garden, all areas should be accessible to individuals of all physical abilities through proper trail surfacing, slopes, and widths (Leadlay and Greene 1998). A hierarchy in all designed elements should be used to help with way finding (Leadlay and Greene 1998). Seating and shade, as well as refreshments, should be provided at regular intervals throughout the garden, such as at interpretive points (Greenhouse and Socolofsky 1997; Portico Group 1997). In cooler climates, adequate seating should be provided in sunny areas

(Leadlay and Greene 1998). Restrooms should be located so that one is within a 10-minute walk from any point in the garden (Leadlay and Greene 1998). Quiet, comfortable places should be provided for people to sit and contemplate their surroundings, as this could lead to an enhanced appreciation of nature (Cohen 2007). Places should be created that will give people the opportunity to come together, whether through informal social contacts or as part of an event (Fromme 2006).

To increase visitor traffic, botanic gardens should make efforts to attract tour groups, which are often interested in visiting (Benfield 1999). Such efforts should include providing adequate and convenient bus parking, emphasizing maps over educational programs, providing general information about the garden, providing adequate seating within the garden, providing tour guides, selling snacks instead of a full meal, and providing a gift shop (Benfield 1999).

While it may not seem directly related to any scientific mission a botanic garden may have, the provision of visitor amenities encourages visitors to stay for longer periods of time (Rakow 2006b). One survey found that one-third of garden visitors stayed for about two hours (Benfield 1999). People visit botanic gardens in part for pleasure, and they should not go away disappointed (Hoversten and Jones 2002). If people have a good experience in the garden they are more likely to come back (Benfield 1999), which may lead to learning and modified behavior.

## **Aesthetics**

Because only humans seek to find, create, and preserve beauty in the world around them (Cohen 2007), botanic gardens should be beautiful, aesthetically pleasing places (Cohen 2007; Rakow 2006b; Fromme 2006). By attracting and involving people, beauty can create an emotional attachment with nature that is the first step to caring and conservation (Cohen 2007). Beauty in a botanic garden should include both natural and man-made elements, arranged according to basic aesthetic principles. Careful design should use different materials to speak to multiple personality types (Gray 2006).

Contrasts such as flower colors on a green matrix, or beautiful displays against an ugly urban backdrop should be used to highlight the beauty of native plants and landscapes (Lindemann-Matthies and Bose 2007; Iain Robertson 1989). In representing habitats and landscapes, the spatial qualities of the target habitat or landscape should be portrayed, as well as its plants (Portico Group 1997).

In plant displays, different vegetation textures, shapes, and patterns should be used to create visual diversity (Lindemann-Matthies and Bose 2007). Canopy trees and water features should be provided (Lindemann-Matthies and Bose 2007). Ornamental plant characteristics, such as color, should be chosen in response to the local climate (Leadlay and Greene 1998). For example, in cooler climates, plants that flower late in the season, have brightly colored seed pods, or that are evergreen should be used (Leadlay and Greene 1998). Where daylight is limited, plants with lighter colors, such as white or yellow flowers,

should be used because they are visible from greater distances (Leadlay and Greene 1998).

To help unify varied plantings, buildings and any man-made elements should be constructed in a consistent style throughout the garden (Leadlay and Greene 1998). Because materials convey particular meanings they should be chosen carefully (Gray 2006). To achieve a regional flair in the garden, construction details, construction techniques, and material choices should be left to experienced local workers (Leadlay and Greene 1998). Horticultural and aesthetic traditions that originated in northern Europe should not be applied unthinkingly in any garden (Robertson 1997). Examples of architectural elements that reflect the climate and cultural influences of the region (Portico Group 1997) should be found, respecting the constant changes inherent in cultural ideas of form and design (Treib 1995).

Finally, some of the best and most intensive displays should be placed at the garden entrance and along access roads because these form the visitor's first impression of the garden (Leadlay and Greene 1998).

## **Summary**

This review of design guidelines from the literature brought to light a number of things. The most specific guidelines were developed by professionals in a related area of expertise. Purpose and design go hand in hand. In garden design, it is very difficult to separate education from conservation, conservation



from the organization of collections, and garden structure from any one of the three.

The design of a modern botanic garden should begin with a detailed and carefully thought-out mission/purpose statement. From there, all the elements of aesthetics, infrastructure, visitor comforts, collections display, conservation considerations, and education should be considered and dealt with at the same time.

Many of the historical purposes that guided the design and layout of historic gardens are no longer relevant (Robertson 1989). Therefore, modern botanic gardens should be looking for new design forms that address the nature-related problems the world is facing today (Robertson 1989).

#### **QUESTION 6: WHAT DESIGN GUIDELINES HAVE BEEN SUGGESTED FOR RELATED INSTITUTIONS SUCH AS ETHNO-BOTANIC GARDENS?**

The literature distinguishes an ethno-botanic garden from other types of botanic gardens as a one with a specific focus on native plants used by indigenous peoples for food, medicine, textiles, shelter, etc. (Harshberger 1896; Meilleur 1991; Skye 1997). In addition, their collections should focus on plants with historical, contemporary, and future values to local peoples (Harshberger 1896; Meilleur 1991).

Because ethno-botanic gardens are mostly about education, the design and development guidelines found in the literature often deal with improving the

educational experience for visitors. This is one of the factors that makes them worth considering in the context of conservation botanic gardens. The focus of ethno-botanic gardens on the human-plant relationship is another factor that makes their design relevant to the current conversation.

What makes a good ethno-botanic garden? First, the ethno-botanic garden must have and adhere to a clearly defined mission statement (Jones and Hoversten 2004). Second, it must focus on visitors while capitalizing on the resources provided by the site (Jones and Hoversten 2004). Third, the garden must tell a compelling story (Jones and Hoversten 2004). Fourth, it should provide an environment conducive to learning (Jones and Hoversten 2004). Fifth, it must be able to adapt through time (Jones and Hoversten 2004).

To accomplish these five things and provide a positive educational experience, one source suggests that special attention be given to certain experiential concepts. These concepts are arrival, decompression, reception, orientation, interpretation, and transformation (Jones and Hoversten 2004). The explanations in this paragraph for each concept are from Jones and Hoversten (2004). A good arrival clearly indicates the beginning of a new area with a clear entrance and well-defined space. Decompression entails providing a space where visitors can rest physically and mentally at the beginning of each new experience. Reception refers to preparing the visitor's mind for learning. Orientation requires that sufficient background information be provided so that each learning experience makes sense. Interpretation requires material that

provokes thought and new viewpoints. Transformation should occur inside the visitor as a cumulative effect of the garden experience.

Because a visitor's physical comfort is critical to mental comfort and learning, the successful ethno-botanic garden should provide a well-designed physical environment that provides harmony, immersion, proximity, and access (Jones and Hoversten 2004). The explanations given below for these terms are, again, from Jones and Hoversten (2004). Harmony requires a certain level of planned consistency between spaces in the garden as they are experienced by visitors. Immersion effectively removes the visitor from other parts of life to get them fully involved in the world of the garden. Proximity refers to minimizing the distance between visitors and plants, as well as other collections, in a safe and controlled way. Access is required for visitors to physically get to the garden's resources.

Perhaps the most important guideline for the design of an ethno-botanic garden is that the garden's story be integrated into the overall plan and design and related to visitors' everyday lives (Jones and Hoversten 2004).

Other physical design elements that should be included in an ethno-botanic garden include the following. Physical facilities and visitor amenities should be integrated into the spatial organization and circulation patterns of the garden (Jones and Hoversten 2004). Protective separation between visitors and exhibits should preserve the ambience and allow for maximum sensory interaction (Jones and Hoversten 2004). Interpretive exhibits should involve all of a visitor's senses and be in scale with the site and other interpretive elements

(Jones and Hoversten 2004). The spatial organization and physical layout should reflect the site's opportunities and constraints while also reflecting the storyline divisions and topics (Jones and Hoversten 2004). The materials palette should reflect the culture being portrayed, with every detail contributing to a clear and consistent, plant-centered message (Jones and Hoversten 2004). Construction technology used in the garden should be consistent with the culture being portrayed (Jones and Hoversten 2004).

The garden and its displays should accommodate multiple learning styles, allow experiential learning, and be physically and mentally inviting (Jones and Hoversten 2004). Ultimately, the garden should not try to tell too many stories, but should cull a few ideas that visitors can take with them when they leave and apply in their lives (Jones and Hoversten 2004; Klemmer and Skelly 2006).

Interpretive and educational design is pertinent to all botanic gardens, but for discussion purposes, it fits well in the context of the ethno-botanic garden, and will be addressed here. It has reference to the spaces and exhibits constructed to inform or educate visitors. Conceptually, good interpretive design will first provide an opportunity to learn, second allow the individual to learn on his or her own terms, and third provide a non-threatening setting (Vandiver 1991). Truly effective interpretive design requires a high level of visitor trust in the sponsoring institution (Vandiver 1991). Interpretive design must consider underlying concepts, the consumer, and the relevant constraints (Vandiver 1991). A good interpretive space will employ minimal signage, create emotional

experiences, reflect the creativity of the designer, and use materials purposefully (Gray 2006). Content should take precedence over design (Vandiver 1991).

Physically, good interpretive elements should combine different media to convey the message or story, such as text, imagery, actors, and digital media (Gray 2006). They should minimize signage and rely more on spatial design and landscape elements to invoke emotion and allow personal learning experiences (Gray 2006). Signage should include powerful quotations that allow people to learn through contemplation (Gray 2006).

## **Summary**

A study of the design and planning of ethno-botanic gardens, with their educational focus, can provide a wealth of information on how to improve the educational experience in any garden. This information is particularly applicable in conservation botanic gardens because education is such an important part of their mission.

Of the ethno-botanic garden design elements mentioned in this section, the planner or designer of a conservation botanic garden should give special attention to the importance placed on mission, story, and environment; the role of experience and how to orchestrate it; the effects of the physical environment, including amenities, on learning; the need to accommodate multiple learning styles; and the components of good interpretive and educational design.

## CHAPTER 3

### METHODOLOGY

The conservation design guidelines for botanic gardens presented in Chapter 5 were developed by synthesizing information found during the literature review and combining it with information from other fields of study and with experience gained developing a master plan for the Belize Botanic Gardens (BBG) in the country of Belize. Research involved the literature review, visits to botanic gardens, and the development of the BBG master plan. The literature review focused on botanic garden history, purpose, and design, and was supplemented with general principles of conservation and sustainability.

The literature review revealed that much has been written about botanic garden purpose, botanic garden design, and the connection between the two. Much has also been written about the conservation mission proposed for botanic gardens. However, little has been written that adequately addresses conservation design within a botanic garden.

Familiarity with BBG was gained through two visits to the garden totaling six days. Experience with this garden underlies this author's perceptions of what a conservation botanic garden should be, although visits to two botanic gardens in Utah provided helpful insights. Time and resources precluded visits to additional botanic gardens. Decisions for the BBG master plan were based on principles of good landscape site design and BBG's most pressing needs.

The master plan (included in the Appendix) was completed before most of the literature review. In some ways, the process may have been more effective if the literature review had been completed first. However, the approach used produced information and experience that provided a context for the information found in the literature, and was therefore beneficial.

The understanding gained of BBG and its site is used in Chapter 6 to show an idealized implementation of the conservation design guidelines proposed in Chapter 5 for botanic gardens.

## CHAPTER 4

INTRODUCTION TO CONSERVATION DESIGN GUIDELINES FOR BOTANIC  
GARDENS

In discussing the development of any botanic garden, it is essential to remember the connection between purpose, mission, and design. The mission, or overall purpose of a botanic garden, should guide all design decisions, and design decisions should support the mission, as indicated in the literature review. When the design is more likely to be noticed and appreciated than the mission, this principle has been forgotten. In the conservation botanic garden, this consideration has added importance because the design can, in many ways, be the message.

By way of review, the meaning of “conservation” in the present context, as explained in Chapter 1, is the protection and management of a natural resource to prevent its destruction (*Merriam-Webster's Collegiate Dictionary* 2003). As explained in Chapter 2, a conservation botanic garden is one that developed in response to local conservation needs, contains or is associated with areas of natural vegetation, focuses exclusively on plants native to the region, and engages in public education (Wyse Jackson and Sutherland 2000). In short, a conservation botanic garden is one that attempts to protect or manage natural, native vegetation and habitats and display them and their management processes to visitors.



Because mission is so important to design, the conservation mission of a botanic garden must be carefully selected and well defined. There are many ways in which a botanic garden can participate in conservation. A summary of specific conservation activities, from the literature, that are applicable to botanic gardens includes:

- Conserving and protecting rare and endangered species through in situ and ex situ plant conservation, the development of in situ plant conservation methods, the propagation of endangered plants, and the sharing of best plant conservation practices with other gardens and outside institutions (Botanic Gardens Conservation International 2000)
- Conserving plant genetic material by keeping conservation collections (Botanic Gardens Conservation International 2000)
- Conserving and protecting large areas of native habitat (Hamann 1987)
- Protecting critical habitat areas or natural biotic resources
- Studying restoration methods at landscape, community, and population scales (Botanic Gardens Conservation International 2000)
- Researching ways to protect biodiversity by studying plant genetics, species, and habitats; cultivating native species both common and rare; developing methods to control invasive exotics; and promoting the use of ecologically responsible (non-invasive) plants by the horticultural industry and the public (Botanic Gardens Conservation International 2000)
- Researching ways to use regionally native plants and landscapes in development; showcasing native plants where natural habitats do not

exist; and becoming key partners in the development of city landscapes (Botanic Gardens Conservation International 2000) that tend to conserve resources such as water, air quality, soil, energy, and wildlife diversity; and/or that become regenerative over the long term (Thayer 1989)

- Using garden resources to educate the public, spread the conservation message, and raise awareness of the fragility of biodiversity and the need to conserve it (Botanic Gardens Conservation International 2000)
- Recognizing the social and economic benefits of plant diversity by promoting local cultural and regional qualities (Botanic Gardens Conservation International 2000)
- Incorporating sustainable practices into daily operations by using sustainable infrastructure and services (Botanic Gardens Conservation International 2000)
- Participating in collaborative conservation efforts with other gardens and institutions (Botanic Gardens Conservation International 2000)

Some of the conservation activities just listed will be neither helped nor hindered by a garden's physical design. Others, however, cannot be executed successfully without careful, appropriate, well-planned design. These include:

- Showcasing native plants where natural habitats don't exist,
- Using regionally native plants and landscapes in development,
- Incorporating sustainable practices into daily operations, and
- Using garden resources to educate the public.

The Proposed Conservation Design Guidelines for Botanic Gardens that come later will focus on these four conservation activities under the headings:

- Presentation of Native Habitats,
- Presentation of Native Plants in Man-made Landscapes,
- Sustainable Practices in Daily Operations, and
- Educational Components.

In addition to information from the literature that is specific to botanic gardens, the design guidelines include principles and information from related fields. To clarify the proposed guidelines, these principles and information are now introduced under the headings “Principles of Conservation,” “Sustainable Construction Guidelines,” and “Principles for Representing Nature” below. The Proposed Conservation Design Guidelines for Botanic Gardens follow in the next chapter.

## **PRINCIPLES OF CONSERVATION**

These are principles from the field of conservation and might be considered the five basic principles of conservation design at the landscape level.

- (1) Habitat Patches: Patches are areas of habitat of significant size. In essence, large patches are better than small patches, connected and/or contiguous patches are better than separated or fragmented patches, multiple patches are better than a single patch, and close proximity

between patches is better than large distances (Johnson, Bentry, and Rol 1999).

(2) Corridors: Corridors are vegetated links between patches that allow organisms to move from one patch to another. When it comes to corridors, continuity is better than fragmentation, wide is better than narrow, and multiple corridors are better than one (Johnson, Bentry, and Rol 1999). Natural corridors should be maintained or restored (Johnson, Bentry, and Rol 1999).

(3) Matrix: The matrix is the most dominant landscape element in a given area, and it is the fabric on which patches and corridors sit. For example, the cultivated land in a farming valley would be the matrix of the area, with patches and corridors of native vegetation distributed throughout, perhaps along a river bottom. If the matrix does not consist of habitat, manage the matrix so that it does not harm habitat patches and corridors (Johnson, Bentry, and Rol 1999).

(4) Structural Diversity: Structural diversity refers to the amount of variety in vegetation types, heights, and ages in a patch or corridor. When wildlife is involved, greater diversity will typically result in greater species richness, all other factors being favorable (Johnson, Bentry, and Rol 1999). Structural diversity should be protected and nurtured (Johnson, Bentry, and Rol 1999).

(5) Edge Effects: These are the influences, such as the noise of human activities, that extend into a habitat patch from its edges. They penetrate

the same distance into a patch, no matter the patch size (Soule 1991).

Different animals require different amounts of habitat undisturbed by edge effects. When patches become too small for a particular animal, the patch no longer provides viable habitat, and the animal will be extirpated.

Therefore, edges should be minimized.

### **SUSTAINABLE CONSTRUCTION GUIDELINES**

To maximize its message and avoid potential hypocrisy, any botanic garden claiming a conservation mission should practice sustainability from the outset. The following summarized guidelines for sustainable construction (North Carolina Botanical Garden 2004), or a similar system, should be the default construction procedure followed by any botanic garden.

- (1) Inventory and protect significant natural areas
- (2) Protect water quality
- (3) Cluster development, natural areas, and corridors to prevent fragmentation
- (4) Minimize environmental impacts
- (5) Landscape and restore the site to achieve its highest and best use for conservation
- (6) Continue environmental protection and awareness after development

Additional sustainable site development guidelines are suggested in the preliminary *Standards & Guidelines* report of the Sustainable Sites Initiative, which is an interdisciplinary program to develop standards and a rating system

for sustainable land development, similar to the LEED system for buildings (Sustainable Sites Initiative 2007). The report organizes these preliminary guidelines into goals in five categories. They are summarized here (Sustainable Sites Initiative 2007):

1. Soils

- a. Sustain or enhance ecosystem services on-site and in surrounding areas by maintaining or improving soil health.
- b. Avoid the use of harmful pollutants, chemicals, and soil amendments.
- c. Produce zero net waste from the site during and after construction.
- d. Reduce the release of greenhouse gasses associated with soil disturbance.

2. Hydrology

- a. Value all on-site water.
- b. Preserve healthy hydrologic processes on the site.
- c. Promote good water quality and the health of aquatic habitats.

3. Vegetation

- a. Plan and maintain vegetation so that it does not detract from, or so that it enhances, on-site and surrounding ecosystem services.
- b. Reduce the consumption and waste of resources through careful selection of plant materials and through consideration of maintenance requirements.

#### 4. Materials

- a. Efficiently manage resources and materials.
- b. Use landscape materials that are sustainable.
- c. Reduce the use of embodied and operational energy through the selection of materials and maintenance procedures.
- d. During all phases of a project, from construction to ongoing maintenance, avoid materials, products, and practices that may harm people and the environment.

#### 5. Human Well-Being

- a. Design and maintain site conditions specifically to promote human physical health.
- b. Enhance human learning and comprehension through the use of natural elements in site design.
- c. Promote positive social interaction through design.

### **PRINCIPLES FOR REPRESENTING NATURE**

Representations of nature, no matter how authentic, are not reality (Lucas, Maroske, and Brown-May 2006). However, there are ways to represent pieces of nature that are true to the spirit and general character of the source. For example, nature should not be copied, but should be used as inspiration (Morrison 2004). This means that the uniquely identifying elements of a community, such as visually or ecologically dominant plant species and patterns, should be emphasized through stylized abstraction (Morrison 2004). The

structure of the reference community, such as middle-story and edge vegetation, should also be represented (Morrison 2004).



## CHAPTER 5

### PROPOSED CONSERVATION DESIGN GUIDELINES FOR BOTANIC GARDENS

Many general botanic garden planning and design guidelines, applicable to all types of gardens, have been published. They address topics such as garden structure, collections organization, visitor amenities, facilities, and the design process. The guidelines presented here are more specific and focus exclusively on design or planning decisions that can enhance the conservation efforts of botanic gardens.

These design guidelines are divided into five categories, four of which were introduced in Chapter 4. The five categories are:

1. Mission Statement and Site Character
2. Presentation of Native Habitats
3. Presentation of Native Plants in Man-made Landscapes
4. Sustainable Practices in Daily Operations
5. Educational Components.

Little of what follows is novel or unique, as most of the ideas have already been implemented somewhere. However, this may be the first time they are presented together and combined with conservation practices from other areas of study. These guidelines are meant as high-level principles within which smaller-scale design decisions, such as those addressed in the literature, can be made. It must always be remembered, though, that conservation design is a single

overlay in the design process and should be considered in concert with other design considerations.

### **MISSION STATEMENT AND SITE CHARACTER**

1. Develop a specific mission statement for the garden carefully spelling out what conservation activities the garden will pursue, and make all design decisions in support of the mission.
2. Allow the site's context and physical features to guide planning and design decisions, and respect the spirit of place in natural and cultural contexts.

### **PRESENTATION OF NATIVE HABITATS**

1. Select a site that includes or is near native habitat. Where this is not possible, select a site where such habitat could be easily restored.
2. Preserve as much existing native vegetation as possible and make these areas/stands/remnants the planning and organizational foundation, or core, of the garden. See Figures 5-1 and 5-2.
3. Look for ways to preserve or create ecological functionality and allow natural processes to occur.
4. In support of #2, do not relegate areas of native vegetation solely to the outer edges of the garden. See Figure 5-3. If that is where they occur naturally, maintain them there and attempt to pull them into the garden's center. See Figure 5-4.

5. In conjunction with #2, maintain or create linkages or corridors of native vegetation through the garden. See Figures 5-5 and 5-6.
6. In support of #2, 4, and 5, cluster buildings and major development in order to provide additional area for vegetation.
7. Where existing vegetation is not native, does not adequately allow full expression of the garden mission, or must otherwise be supplemented, represent the native communities by creating abstractions and simplifications of natural patterns based on authentic regional ecological communities.
8. Harness the beauty of healthy ecosystems.

### **PRESENTATION OF NATIVE PLANTS IN MAN-MADE LANDSCAPES**

1. Showcase native plants in man-made landscapes to show off their utility and ornamental qualities. Specifically, provide display areas that show how native plants can be used in commercial, residential, and public landscapes to replace more traditional exotics.
2. Demonstrate culturally appropriate ways to integrate healthy native plant communities with larger scale development.

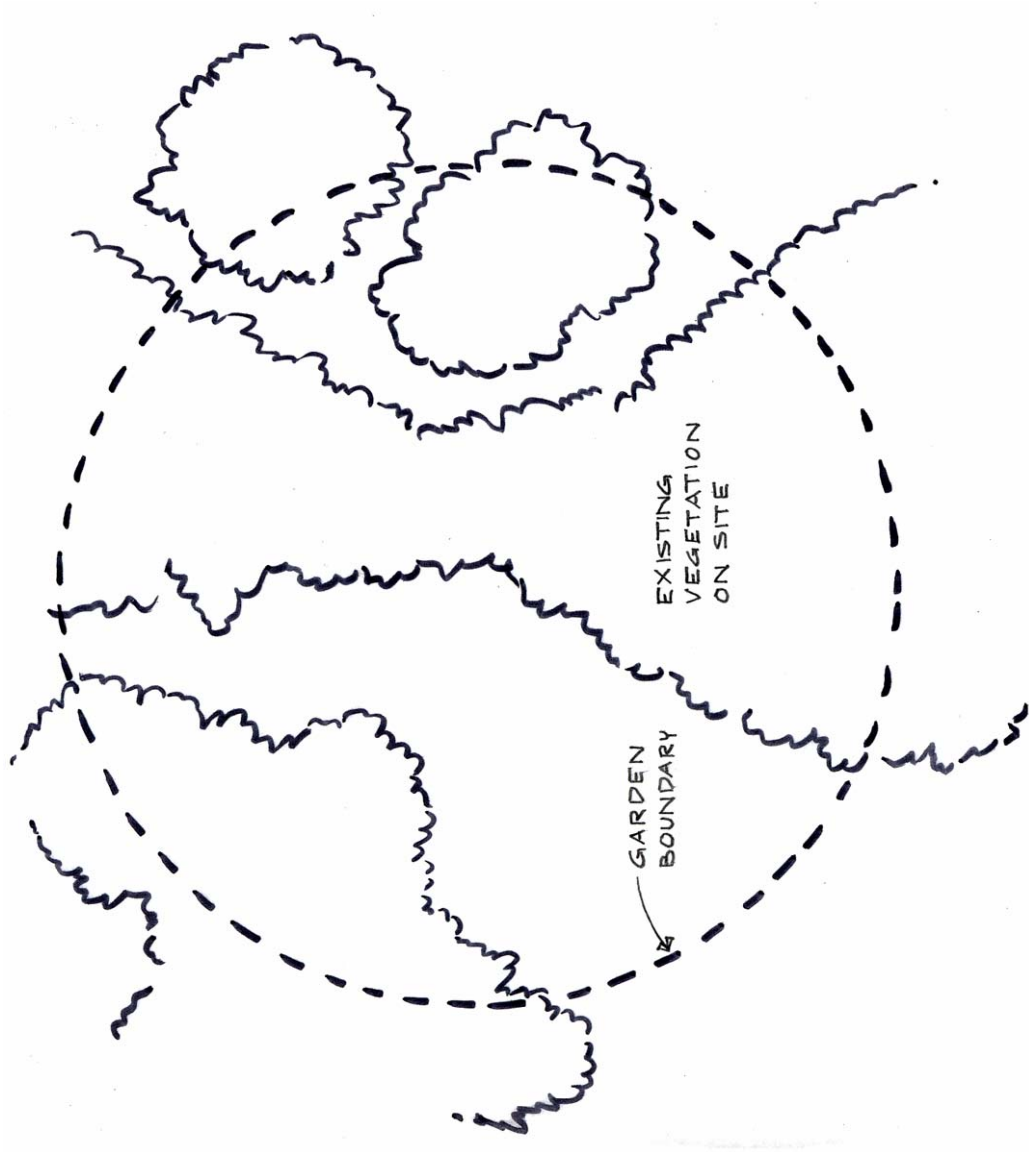


Figure 5-1: Site Conditions Pre-Development

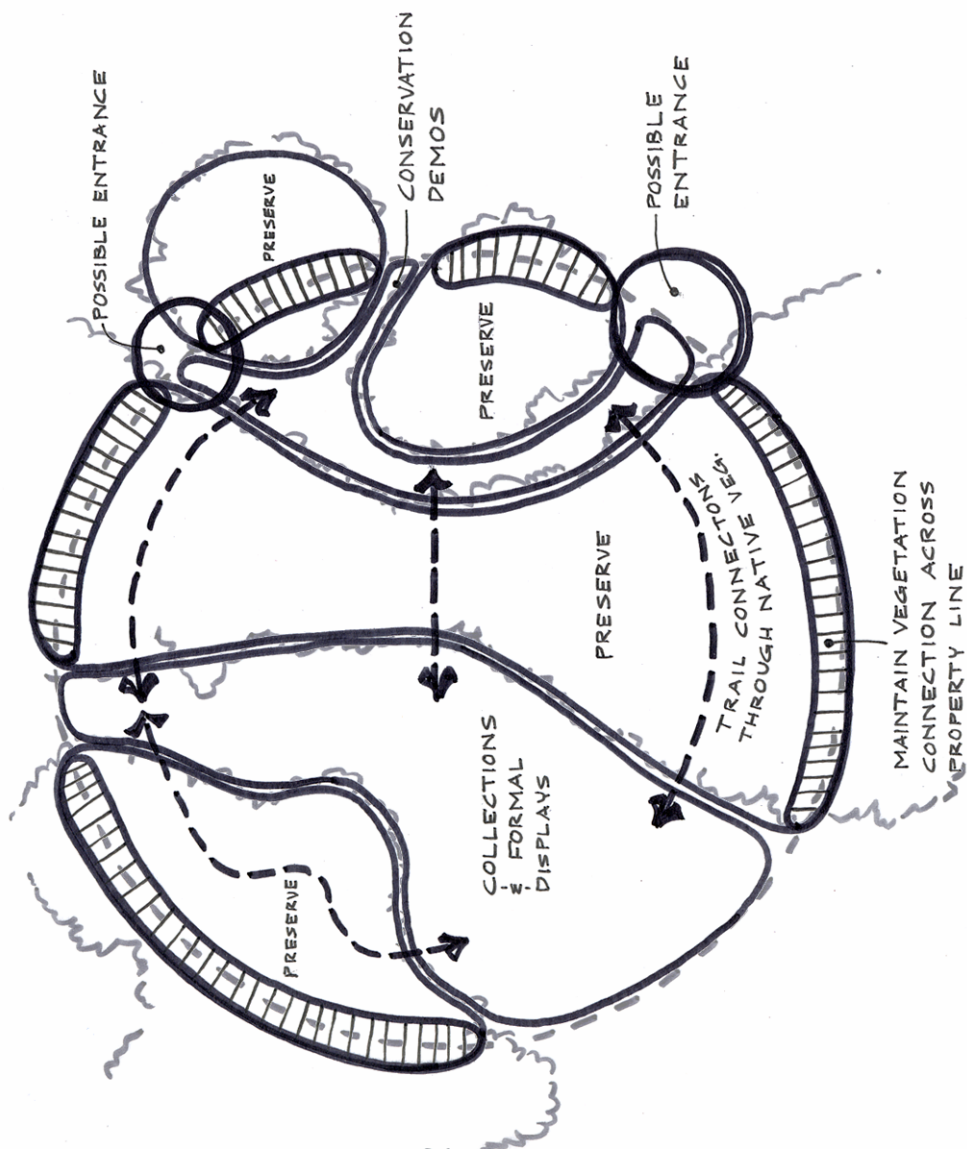


Figure 5-2: Concept Illustration of How to Plan Around Existing Vegetation

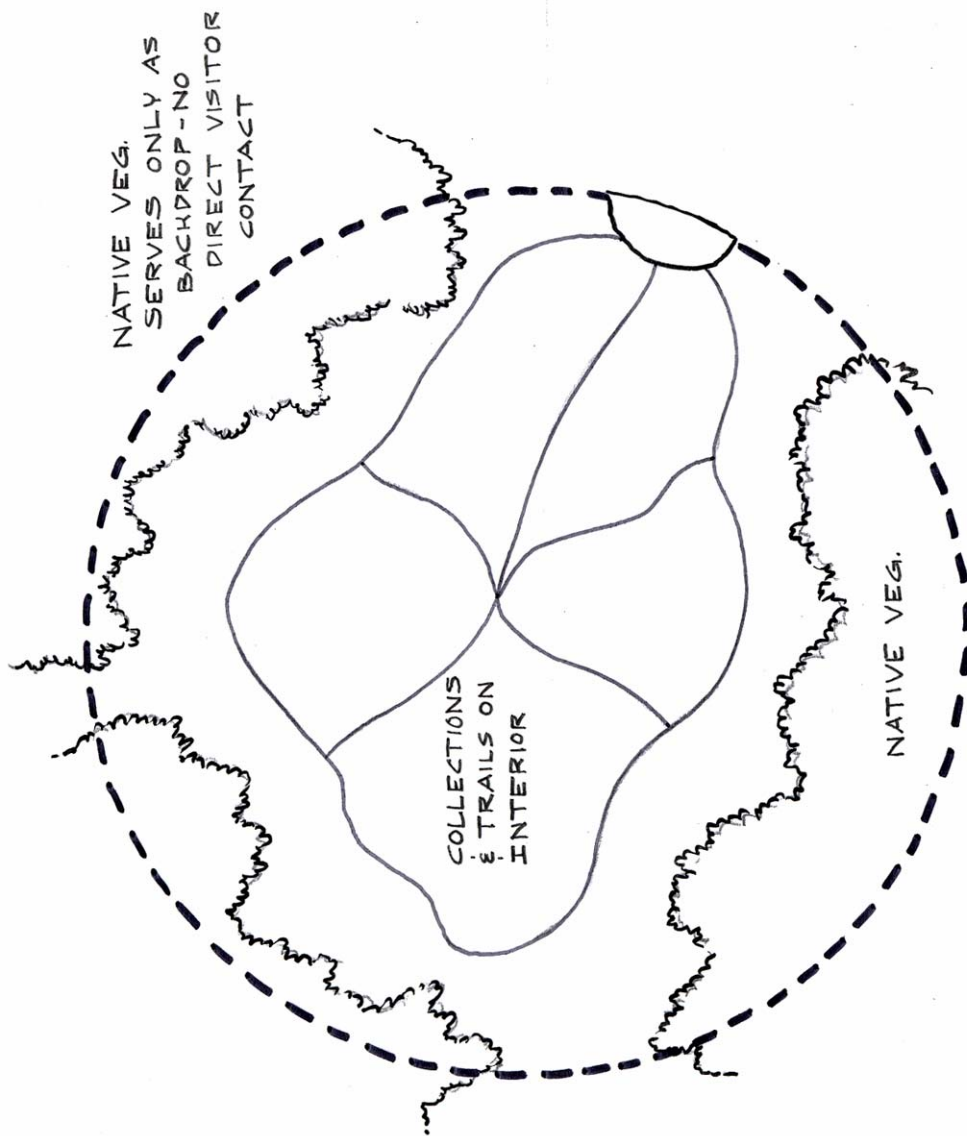


Figure 5-3: Example of How Not to Treat Native Vegetation

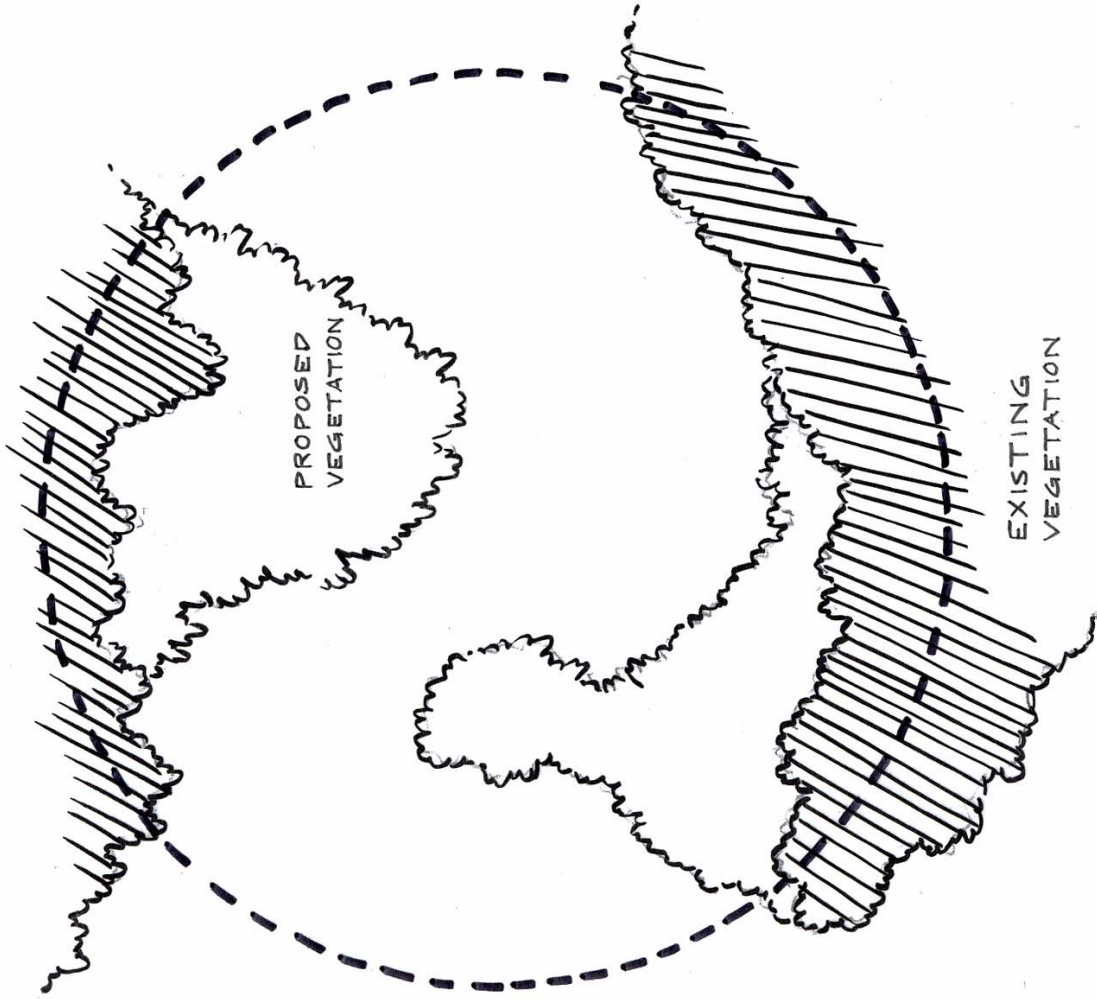


Figure 5-4: One Way of Pulling Native Vegetation into Garden

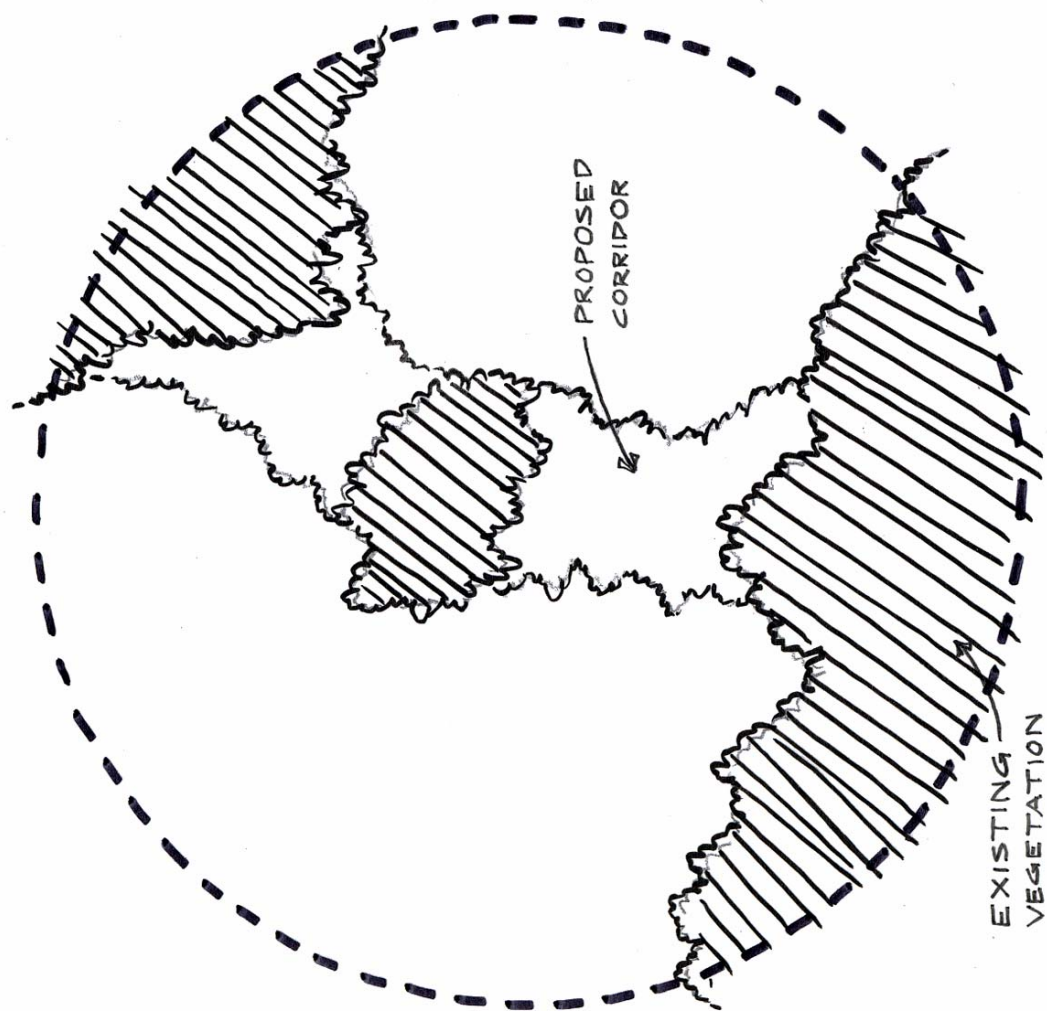


Figure 5-5: Introducing a Corridor through a Garden



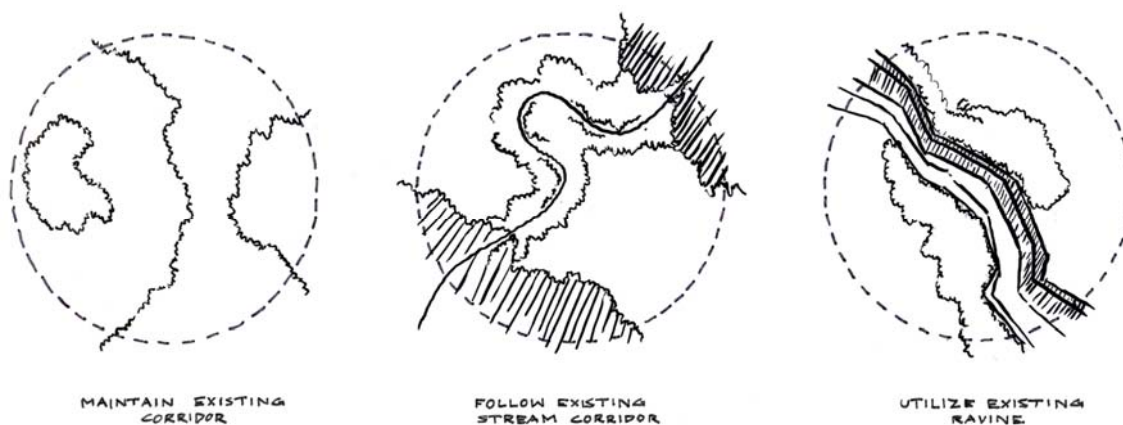


Figure 5-6: Ways of Maintaining a Corridor through a Garden

### **SUSTAINABLE PRACTICES IN DAILY OPERATIONS**

1. Demonstrate a commitment to conservation by using sustainable design principles in all facilities and infrastructure and by following sustainable operational practices. Examples of sustainable operational practices might include eliminating the use of chemical pesticides and fertilizers, maximizing manual labor in maintenance, reducing the use of power equipment, and recycling organic waste on site in the form of compost (Sustainable Sites Initiative 2007).

### **EDUCATIONAL COMPONENTS**

1. Integrate a conservation storyline into the overall plan and design of the garden.
2. Display the garden's mission statement prominently at the entrance, and repeat it throughout the garden.

3. Provide sufficient background information to ensure that an individual display and its message make sense to visitors.
4. Relate the garden's message to visitor's everyday lives so that they take something with them when they leave.
5. Minimize distances between people and plants to maximize sensory experiences and interaction.

## **CONCLUSION**

It is hoped that these conservation design guidelines for botanic gardens can be used to assist botanic gardens in fulfilling a conservation mission. In Chapter 6, the guidelines are applied in a hypothetical redesign of the Belize Botanic Gardens, with the intent that this example will further illustrate and clarify the guidelines.

## CHAPTER 6

## ILLUSTRATIVE EXAMPLE

The Belize Botanic Gardens (BBG) occupy 45 acres of land above the banks of the Macal River near San Ignacio in the Cayo District of Belize. See Figure 6-1. BBG began in 1994, when Ken and Judy duPlooy purchased 45 acres of previously bulldozed cattle pasture. The duPlooy's planted extensively to restore the land to its pre-bulldozer state and attract birds and wildlife back to the site. Along the way, they planted a variety of tropical fruits they thought might have economic value for Belize. As their collection grew, plant enthusiasts, farmers, scientists, and botanic gardens began to take notice. In 1997 the duPlooy's registered BBG as a botanic garden (Belize Botanic Gardens 2008).

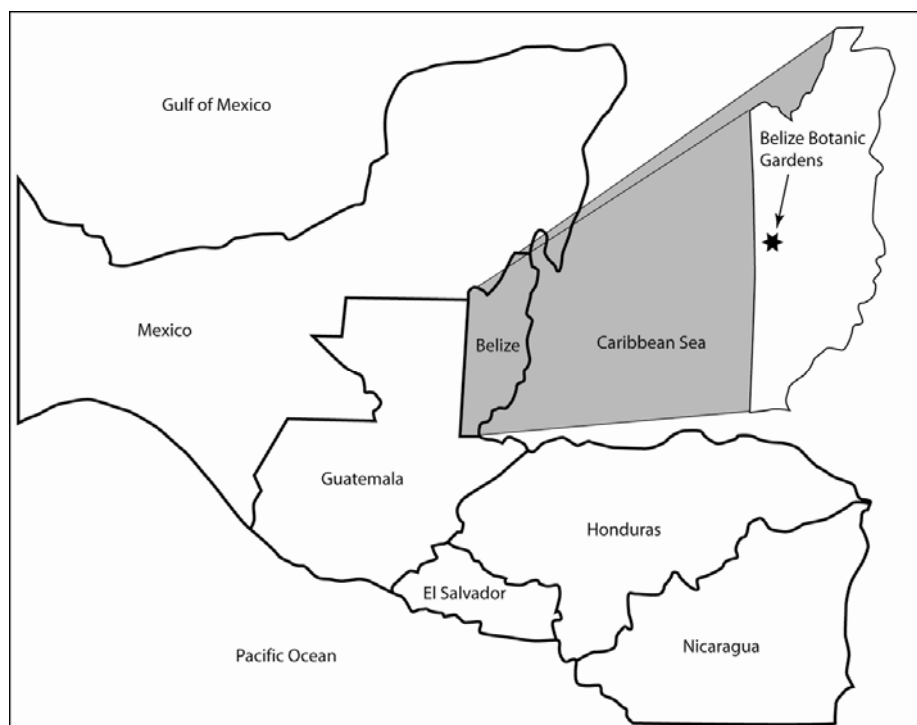


Figure 6-1: Location of Belize Botanic Gardens

The garden's design and development was, in many ways, haphazard. Ken duPlooy planted where he wanted, without a pre-conceived plan. Even so, there is much that is good in BBG and supportive of conservation. However, there are things that could have been done to enhance the garden's conservation mission if planned from the beginning. The master plan presented in the Appendix is based on existing conditions in BBG and does not directly address these conservation planning issues. Therefore, this chapter will walk through a hypothetical and high-level redevelopment of BBG from its original state as bare cattle pasture, in order to illustrate an ideal application of the planning and design guidelines presented in Chapter 5.

There is a danger in using a specific botanic garden as a case study for general conceptual guidelines. It is that the unique requirements of the garden may necessitate adjustment of the guidelines. This is the way it should be. The specific mission, goals, and requirements of the institution, along with specific site requirements, should always override general guidelines such as those presented in the previous chapter.

### **BELIZE BOTANIC GARDENS ALTERNATIVE SITE PLAN**

What follows is a hypothetical exercise. It illustrates a conceptual site master plan for Belize Botanic Gardens that might have resulted if the planning and design guidelines presented in Chapter 5 had been followed from BBG's

inception. This is not the master plan developed for, and implemented at BBG, although the two plans share some similarities.

The process presented below will follow the divisions and steps used in Chapter 5 to introduce the guidelines.

### **Mission Statement and Site Character**

*1. Develop a Specific Mission Statement for the Garden carefully spelling out what conservation activities the garden will pursue, and make all design decisions in support of the mission.*

In keeping with the garden's founding purpose of "establishing an institution that will lead efforts to protect, conserve, study, and disseminate information about the flora of Belize" (Belize Botanic Gardens n.d.), the mission of Belize Botanic Gardens is "to protect the floral diversity of Belize by existing as an information resource for the community, government, industry and science and to be a place of beauty for all visitors to enjoy" (Belize Botanic Gardens 2007). They also "aim to cultivate, promote, research and enable the research of tropical flora and its conservation with an emphasis on [Belizean] native species and their habitats" (Belize Botanic Gardens 2007).

The planning decisions that follow will help BBG contribute to local and global conservation efforts in support of their mission. This will happen in a variety of ways, including conserving regional plants and habitats, introducing ways to integrate development with natural habitats, showcasing the beauty of

native plants, teaching about plants and the need to protect them, and giving visitors many opportunities to have personal contact with plants.

*2. Allow the site's context and physical features to guide planning and design decisions.*

The site selected for BBG is largely clear-cut and heavily grazed, which essentially provides a blank slate for the future. There are some remaining stands of trees and brush. It is adjacent to a river, although high above it, with steep banks leading down. There is some natural topography on the site: the foothills of adjacent mountains that slope into the site, a small rise or plateau, a depression, a ridge, and a ravine. Each of these elements, shown in Figure 6-2, will guide the garden's planning. Note that the topography has been interpolated and may not represent the site's actual topographic character.

### **Presentation of Native Habitats**

*1. Select a site that includes or is near native habitat. Where this is not possible, select a site where such habitat could be easily restored.*

BBG's selected location is a good site. It is surrounded by areas of native vegetation and habitat, as shown in Figure 6-3, so it is possible to integrate natural plants and communities into the garden and connect with the surrounding vegetation. The quick growing native vegetation will readily fill in the cleared areas where desired. The site's relative isolation (see Figure 6-4) will help protect the garden from human intrusions and facilitate the return of wildlife. These factors reduce the potentially detrimental effects of previous clearing and grazing.

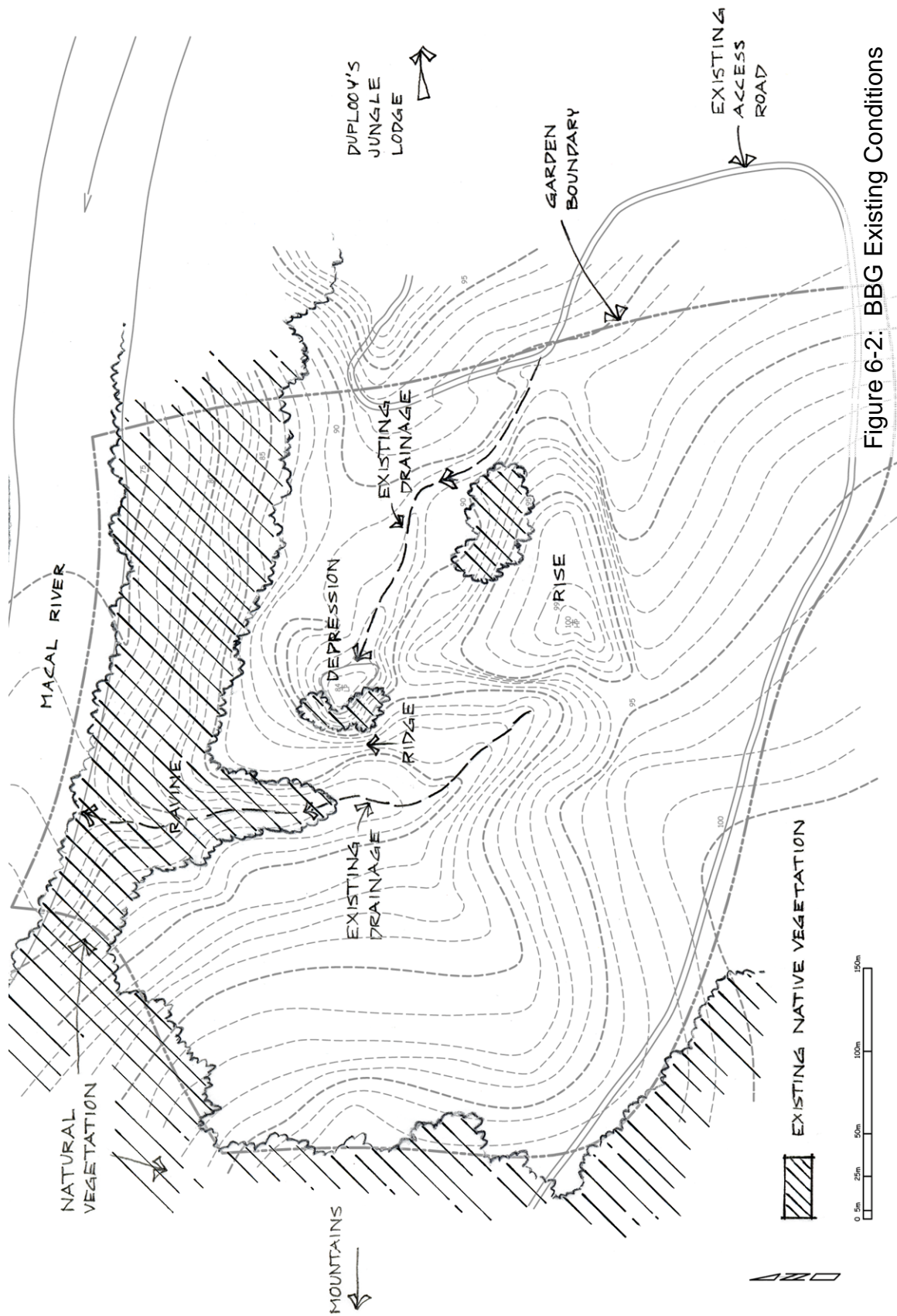


Figure 6-2: BBG Existing Conditions





Figure 6-3: BBG Location in Context with Immediate Surroundings



Figure 6-4: BBG Location in Regional Context



*2. Preserve as much existing native vegetation as possible and make these areas/stands/remnants the planning and organizational foundation, or core, of the garden.*

As shown in Figure 6-2, there are some stands of natural vegetation remaining on the site. The general character of the natural vegetation is shown in Figure 6-5. The remaining stands will be preserved and expanded as shown in Figure 6-6. The resulting forms of these areas, carefully planned to create rooms that will help organize the garden experience, will guide the large-scale site planning decisions, as shown in the concept plan in Figure 6-7.



Figure 6-5: General Character of Existing Vegetation

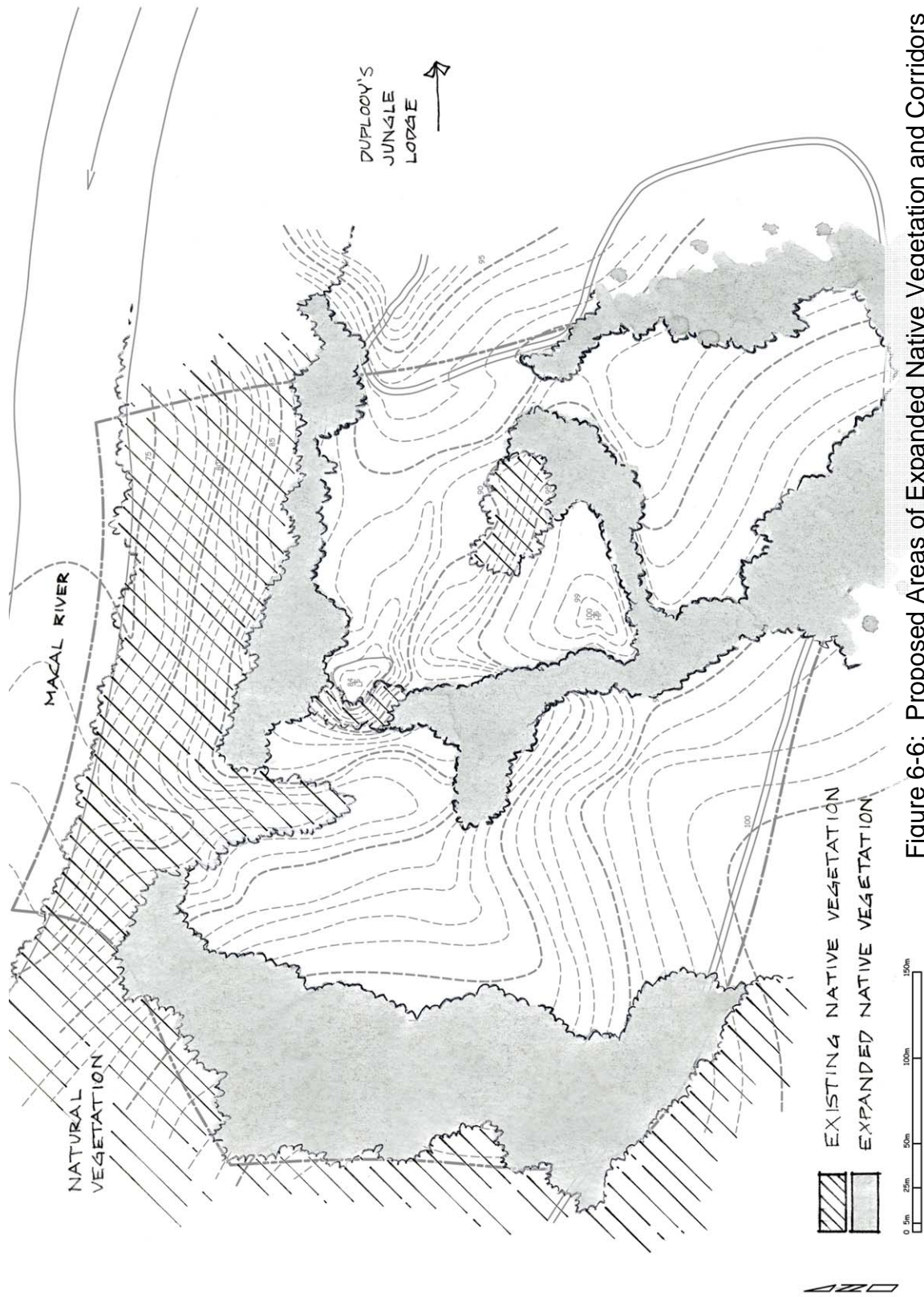


Figure 6-6: Proposed Areas of Expanded Native Vegetation and Corridors



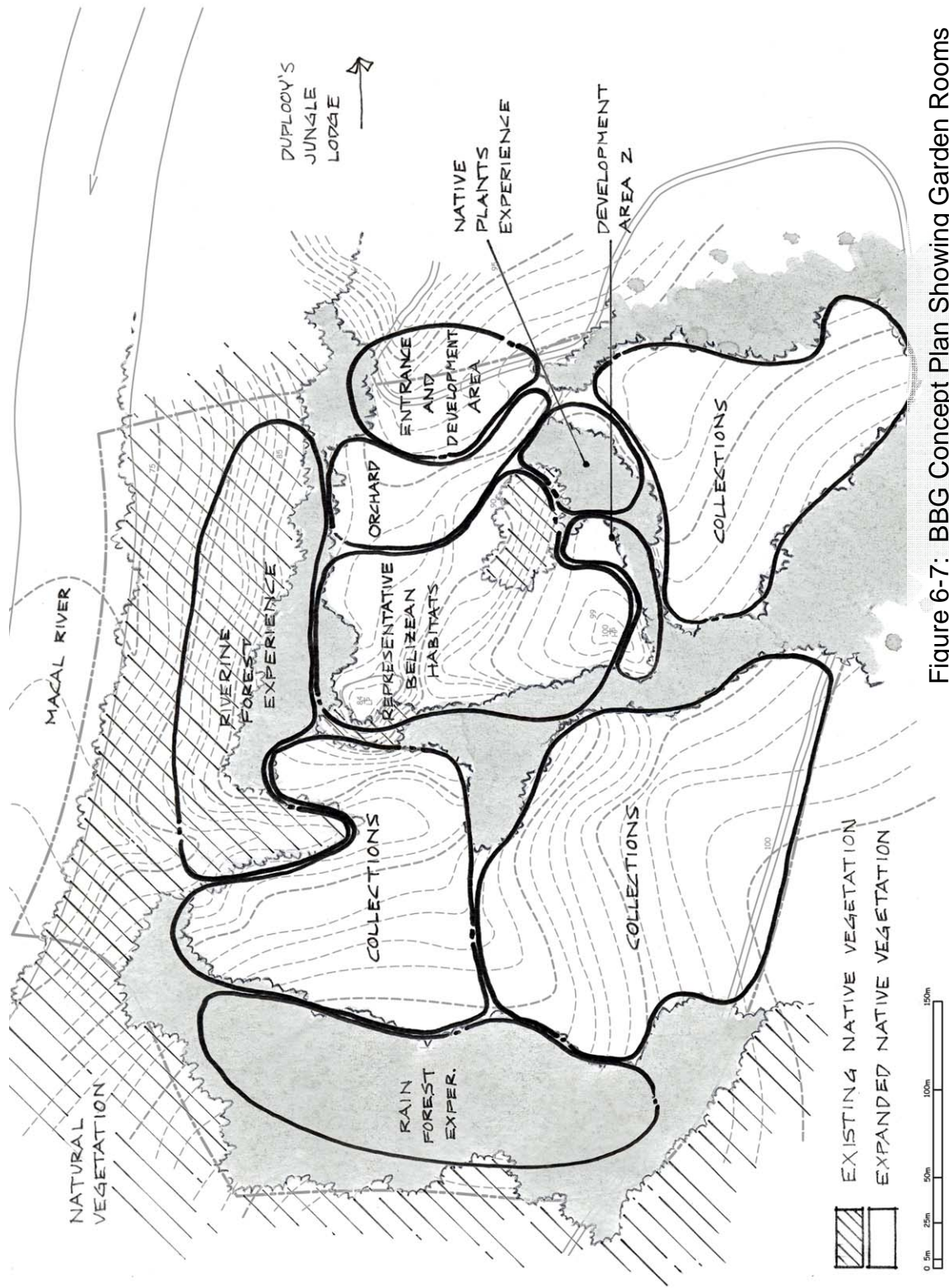


Figure 6-7: BBG Concept Plan Showing Garden Rooms

*3. Look for ways to create or preserve ecological functionality and allow natural processes to occur.*

The simplest way to accomplish this point is to plan areas of native vegetation that will be allowed to grow and change in composition and form according to natural processes of succession. Some management will be necessary to eliminate invasive exotic species and confine these natural areas to the desired location(s) in the garden. But they will otherwise be allowed to grow and change without interference to demonstrate how natural plant communities change over time and thereby provide different ecological services. These areas are identified in Figure 6-8.

*4. In support of #2, do not relegate areas of native vegetation solely to the outer edges of the garden. If that is where they occur naturally, maintain them there and attempt to pull them into the garden's center.*

BBG is located in an agricultural ecosystem in which most of the native vegetation has been removed and/or replaced (Meerman and Sabido 2001). However, immediately across the river from BBG, and at the southern edge of the agricultural ecosystem mentioned, are two varieties of tropical broadleaf lowland forest (Meerman and Sabido 2001). Because of their adjacency, these ecosystems can be used to indicate the types of native vegetation that could be present around BBG and appropriate for pulling into the garden.

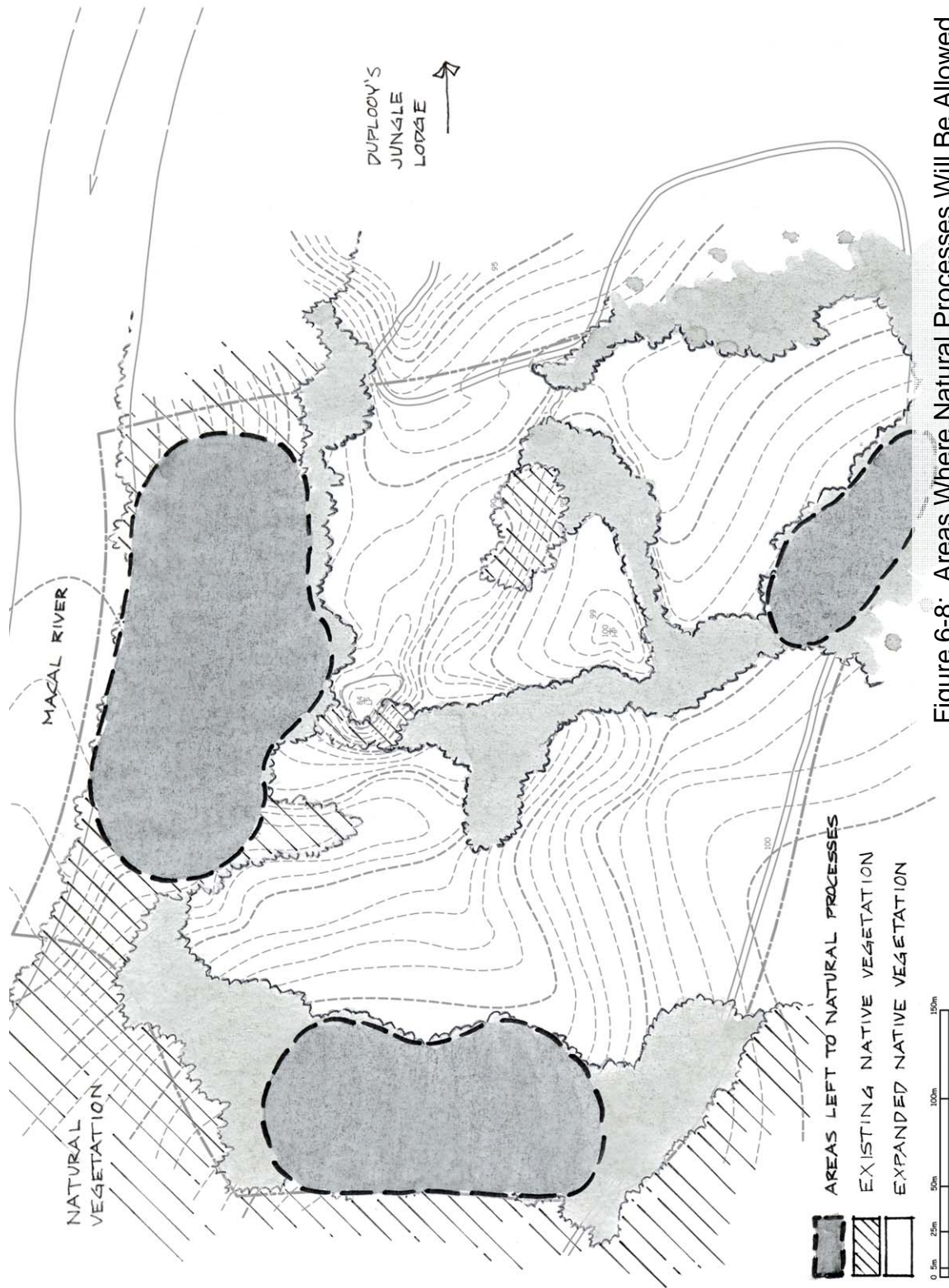


Figure 6-8: Areas Where Natural Processes Will Be Allowed

These two ecosystems share many of the same plants. Their canopies can reach heights of between 30 and 40 meters (98 to 130 feet) (Meerman and Sabido 2001). The understory and shrub layer may contain palms and climbing woody vines, among other types of plants (Meerman and Sabido 2001). The specific species found in these ecosystems are too numerous to list. However, this sampling may give a flavor of the types of natural vegetation that could surround BBG: *Acacia dolychostachya*, *Alseis yucatanensis*, *Attalea cohune*, *Cedrela odorata*, *Sabal mauritiiformis*, *Trichilia havanensis*, *Spondias mombin*, and *Zuleania guidonia* (Meerman and Sabido 2001). The image in the upper-left corner of Figure 6-5 may give some indication of the appearance of these ecosystems' canopies.

As illustrated in Figure 6-6, the native vegetation surrounding BBG and the remnant stands will be expanded to have a more dominant and important role in the garden. Trails will be aligned so that visitors come into contact with these native areas.

*5. In conjunction with #2, maintain or create linkages or corridors of native vegetation through the garden.*

Because BBG is surrounded on at least two sides by large areas of natural habitat and vegetation, likely of the tropical broadleaf lowland forest variety (Meerman and Sabido 2001), it is important to create one or more corridors through the site to allow the distribution and passage of wildlife. Proposed locations for two such corridors are highlighted in Figure 6-9.



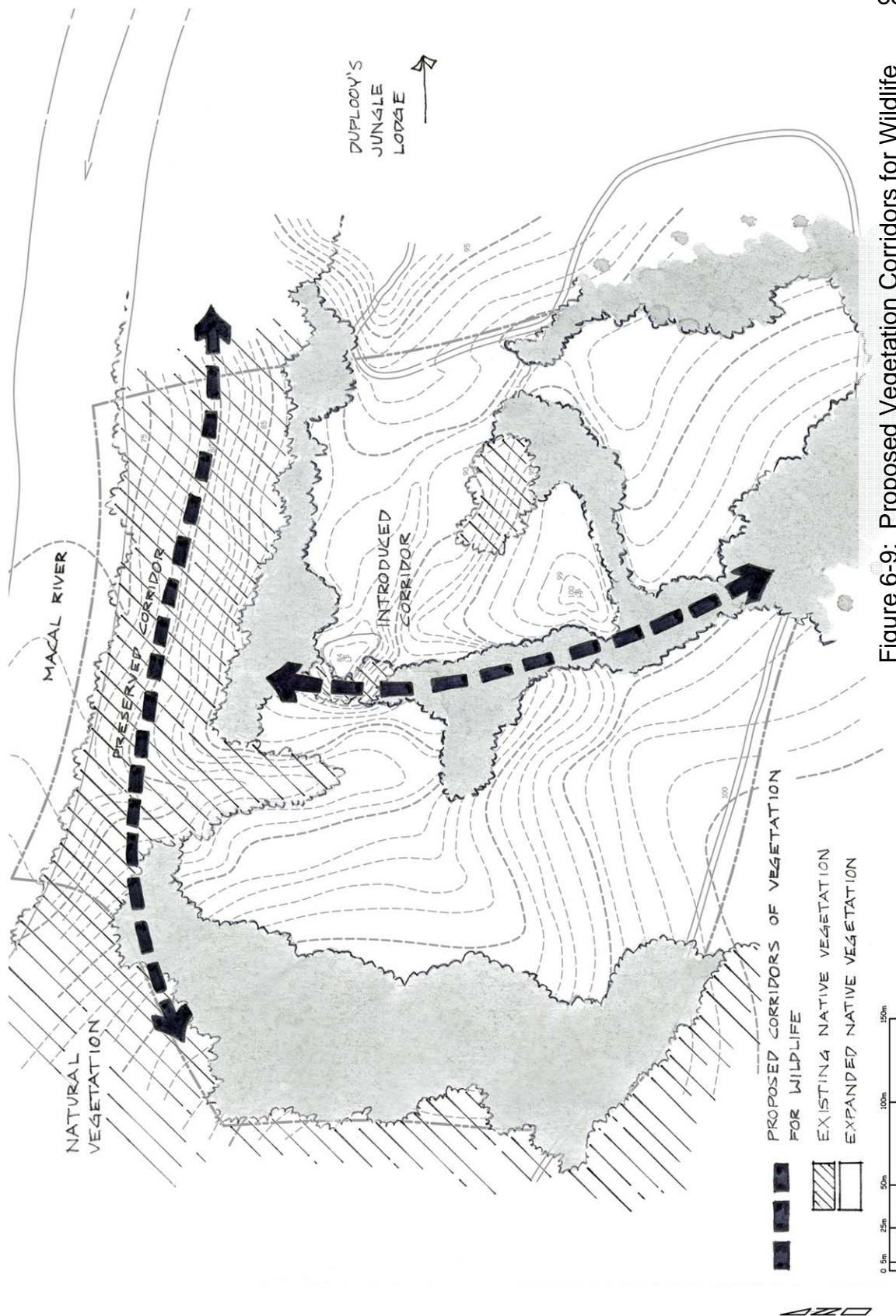


Figure 6-9: Proposed Vegetation Corridors for Wildlife

*6. In support of #2, 4, and 5, cluster buildings and major development in order to provide additional area for vegetation.*

The locations for such clustering on the BBG site are determined by the planned locations of native vegetation and the existing site topography. Not all structures will be in a single cluster. Clustering will focus on the larger proposed buildings, those that will require the largest clearings and could create the biggest obstacles to planned vegetation reintroductions. The buildings planned at this time are an orchid house, a conference center, a green house, an orchid nursery, and an education/research center, as indicated in Figure 6-10.

The illustration in Figure 6-10 shows the locations of these buildings in two clusters. One cluster takes advantage of the views at the top of the existing rise, as well as the level ground. The other cluster benefits from level ground and proximity to the service access at the garden entrance. In general, the planned native vegetation patches and corridors will not be negatively impacted by the buildings and their associated activities.

*7. Where existing vegetation is not native, does not adequately allow full expression of the garden mission, or must otherwise be supplemented, represent the native communities by creating abstractions and simplifications of natural patterns based on authentic regional ecological communities.*

As part of its mission to conserve native Belizean plant species and their habitats, and to disseminate information, BBG will display representative Belizean habitats. The selected habitats were chosen because they represent



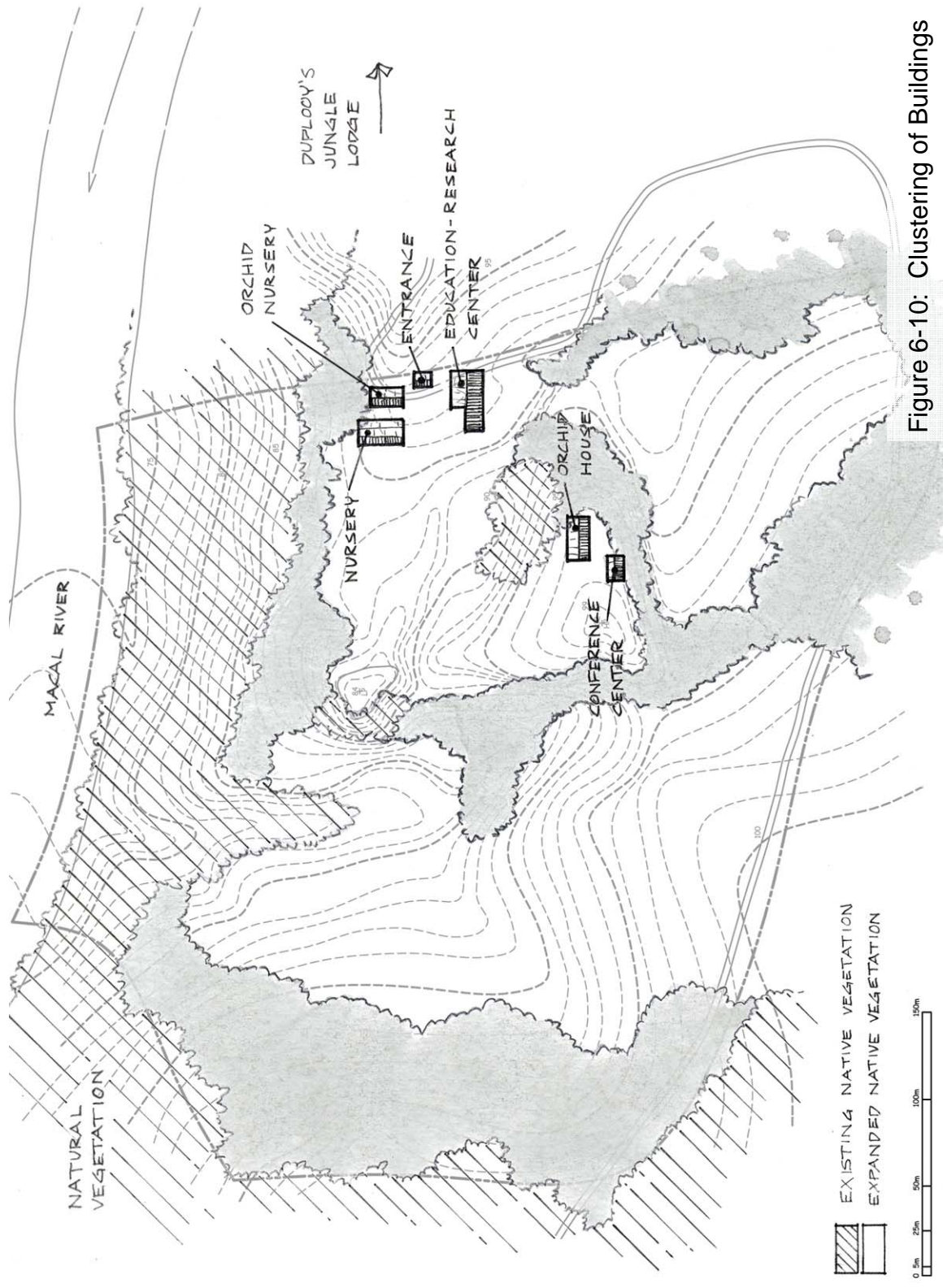


Figure 6-10: Clustering of Buildings

the core habitat types found in Belize (Heather duPlooy, Personal Communication, February 12, 2007). However, BBG's location, climatic conditions, and size are not conducive to reproducing some of these habitats. Therefore, they will be abstracted in the garden and placed in settings as topographically similar to their native conditions as possible. The habitats are organized to represent the order in which they might be experienced in nature if one were to move inland from the ocean, as illustrated in Figure 6-11. A brief description of each habitat follows.

The Water/Mangrove display, centered on the garden's pond and its immediate surroundings, symbolically represents Belize's ocean coasts, and in species selection its mangrove forests and other aquatic ecosystems. The Littoral Edge display represents the area of transition from coastal habitats to inland habitats. The Savanna display is located on a level piece of ground between the pond and the small rise in the garden's center (Figure 6-2). Belize's savannas are located primarily in the eastern lowlands and are typically encountered before forests, if moving inland from the ocean. The Forest Edge display represents the ecotone often found where a forest rises up at the edge of an open space, such as a savanna. The Forest display is meant to represent the many types of tropical broadleaf forests found in Belize and is located adjacent to the forest edge, as would occur in nature. The Mountain Pine Ridge display completes BBG's habitat continuum. It is located at the top of the rise, and represents Belize's high-altitude pine forests.



Figure 6-11: Possible Arrangement of Habitat Displays in BBG

*8. Harness the beauty of healthy ecosystems.*

BBG's location provides a number of opportunities to use surrounding areas as views and backdrops. The climate allows for lush vegetation growth, and the slope to the river allows visitors to experience the interior of a rain forest. These and other elements of the garden allow visitors to experience some of the beauty of nature. Figure 6-12 shows some of the views from within the garden.





Figure 6-12: Sample Views from within BBG

### **Presentation of Native Plants in Man-made Landscapes**

*1. Showcase native plants in man-made landscapes to show off their utility and ornamental qualities. Specifically, provide display areas that show how native plants can be used in commercial, residential, and public landscapes to replace more traditional exotics.*

This will be accomplished at BBG in two primary locations. The first is at the garden entrance. The second is around the Orchid House and Conference Center. See Figure 6-10. These are the two areas that lend themselves to formal design and proximity with man-made elements. Native plants will be used in these areas in attractive arrangements that could easily be replicated in



Figure 6-13: Formal Arrangement of Native Plants around Garden Entrance

residential or urban settings. One possible plant arrangement for the entrance is illustrated in Figure 6-13.

*2. Demonstrate culturally appropriate ways to integrate healthy native plant communities with larger scale development.*

Due to size constraints, it is not possible to directly implement this practice at BBG. However, interpretive material can explain how the developed areas were sited and clustered to preserve the habitat patches and corridors and how these principles could be applied at larger scales.

## **Sustainable Practices in Daily Operations**

*1. Demonstrate a commitment to conservation by using sustainable design principles in all facilities and infrastructure and by following sustainable operational practices.*

All planning and design decisions will respect the site's existing topography and vegetation and minimize disturbance to these features. No pesticides or inorganic fertilizers will be used in the garden. Supplemental irrigation will be minimized and provided as much as possible from captured and stored rainwater.

Structures at BBG, such as the conference center, will be constructed using local, natural materials and local labor as much as possible. For example, bricks will be made locally. Smaller and less permanent structures will be made of simple, indigenous materials, many of which could be harvested from the garden itself.

Visitor amenities will also be sustainable. Composting toilets will be provided for visitor use, and water for washing will come from harvested rainwater.

## **Educational Components**

*1. Integrate a conservation storyline into the overall plan and design of the garden.*

The story of BBG is about the wonder of the plant world and how to protect and preserve it. Belize has a rich, biologically diverse natural heritage

made up of thousands of individual plant and animal species. The walk through Belize Botanic Gardens will reveal three things: (1) The composite beauty of all the many plants in the garden as they create walls and rooms; (2) The beauty to be found in the details of individual plants and plant families; (3) The importance of the connections among all plant life.

Each of these revelations will come from an experience. Walking beneath the rain forest canopy produces a different feeling from walking on the Savanna and grasslands. Studying the details of plant leaves and flowers, their varied colors, textures, and patterns is enlightening and educational.

These varied experiences are possible only so long as the type of biodiversity found in Belize remains, in that country and throughout the world. Every plant and habitat is unique.

*2. Display the garden's mission statement prominently at the entrance, and repeat it throughout the garden.*

BBG's mission statement, as quoted at the beginning of this alternative site plan, will be displayed as part of interpretive information provided at the garden entrance. One way of doing this is illustrated in Figure 6-14.

*3. Provide sufficient background information to ensure that an individual display and its message make sense to visitors.*

The storyline and the mission statement will be expounded upon at each interpretive display, either directly or indirectly. Each display will add another piece to the story, and the story will be used to provide the background



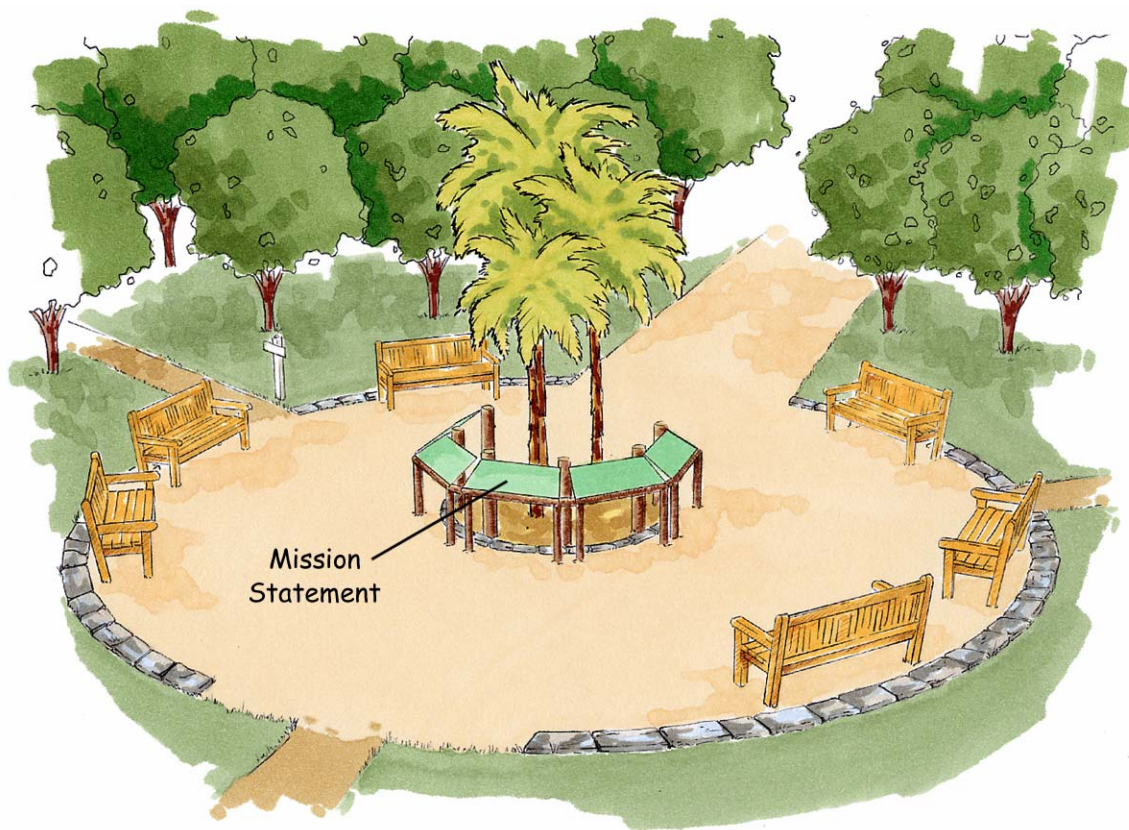


Figure 6-14: Mission Statement Prominently Displayed at Garden Entrance

information for each display. Essentially, the interpretive displays must have context within the global conservation picture. A clear connection between BBG's work and global conservation needs, and how local action can make a global difference, will contribute to visitor understanding of each display.

*4. Relate the garden's message to visitor's everyday lives so that they take something with them when they leave.*

BBG has two principal audiences. One is composed of the local Belizean people. The other is made up of international tourists, some of whom stay at the adjacent resort lodge. The locals might benefit most from an understanding of the value and beauty of their country's native vegetation. BBG can provide this



understanding with interpretive displays that explain the local and global importance of Belizean vegetation and habitats. Displays that demonstrate how to use native plants in man-made settings would further contribute to this end.

Tourists might benefit more from an understanding of the global need for conservation, how their actions thousands of miles away impact other countries, and the importance and value of biodiversity. BBG can provide this understanding with interpretive information that introduces and explains threats to biodiversity. Perhaps more importantly, they can also show the beauty of biodiversity through the displays in the garden.

*5. Minimize distances between people and plants to maximize sensory experiences and interaction.*

Many of the displays and surrounding spaces in BBG will be intimate and naturally bring people into contact with plants. Trails will pass through thick vegetation where visitors can see the details of individual plants and touch and smell them. These opportunities will be enhanced by the inclusion of a sensory garden that will contain plants specifically chosen by BBG staff for their unique textures, aromas, and flavors. Visitors will be encouraged to experience each of these characteristics. Additional hands-on experience will be available through a craft plants display where visitors can create with plant materials. It is hoped that such personal experiences will help visitors better appreciate the value of plants.

The sensory garden may be located in any of the three areas designated for collections. Three potential locations, selected for their proximity to other features, are illustrated in Figure 6-15.

## **CONCLUSION**

The completed site plan, shown in Figure 6-16, is a conceptual plan within which the garden's collections and displays could be arranged. In a botanic garden focused on conservation, a concept plan of this sort should be carefully respected because it will, ideally, place conservation at the fore of all other site planning decisions. This in turn will create a solid foundation from which to preach the conservation message.

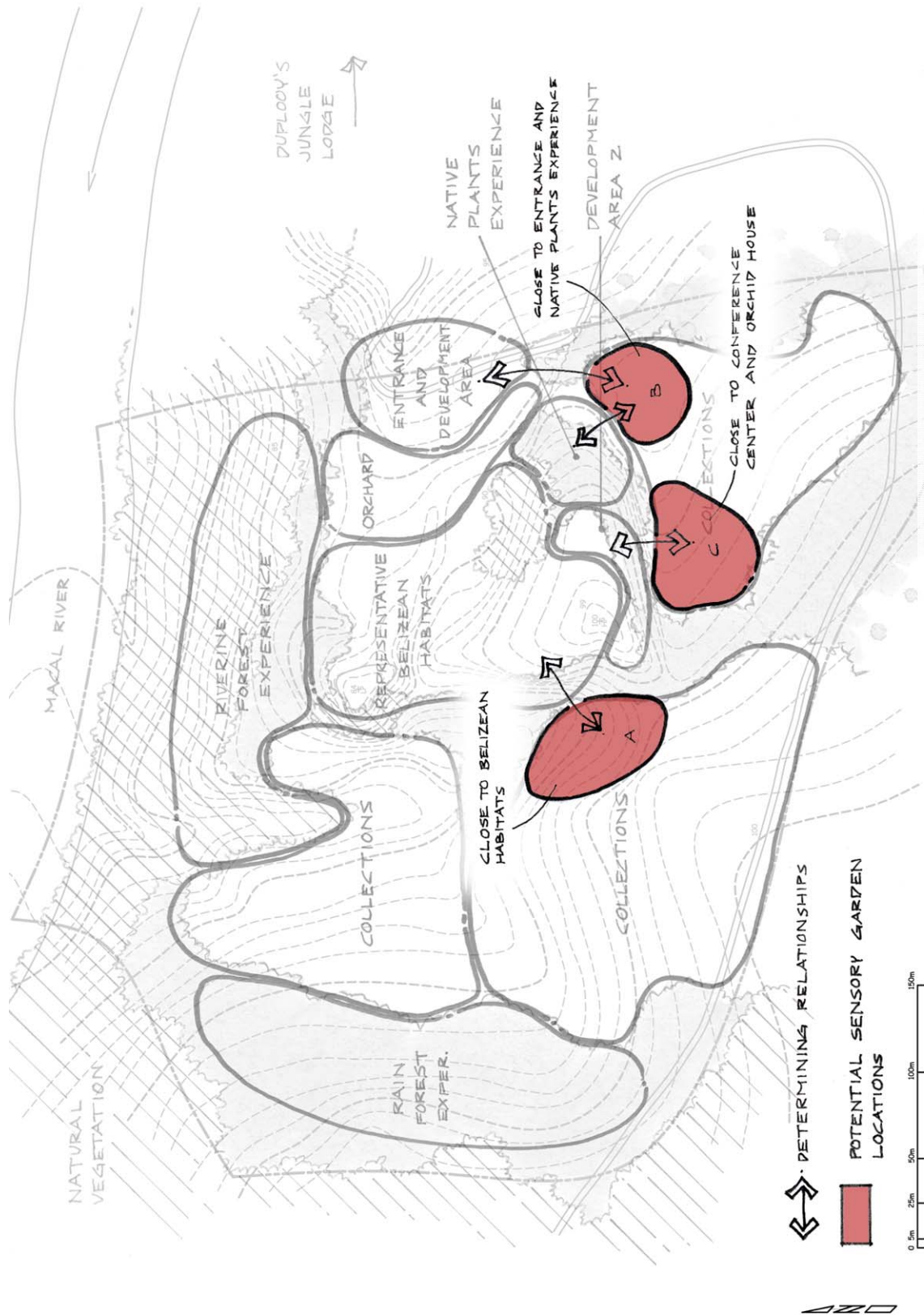


Figure 6-15: Potential Sensory Garden Locations

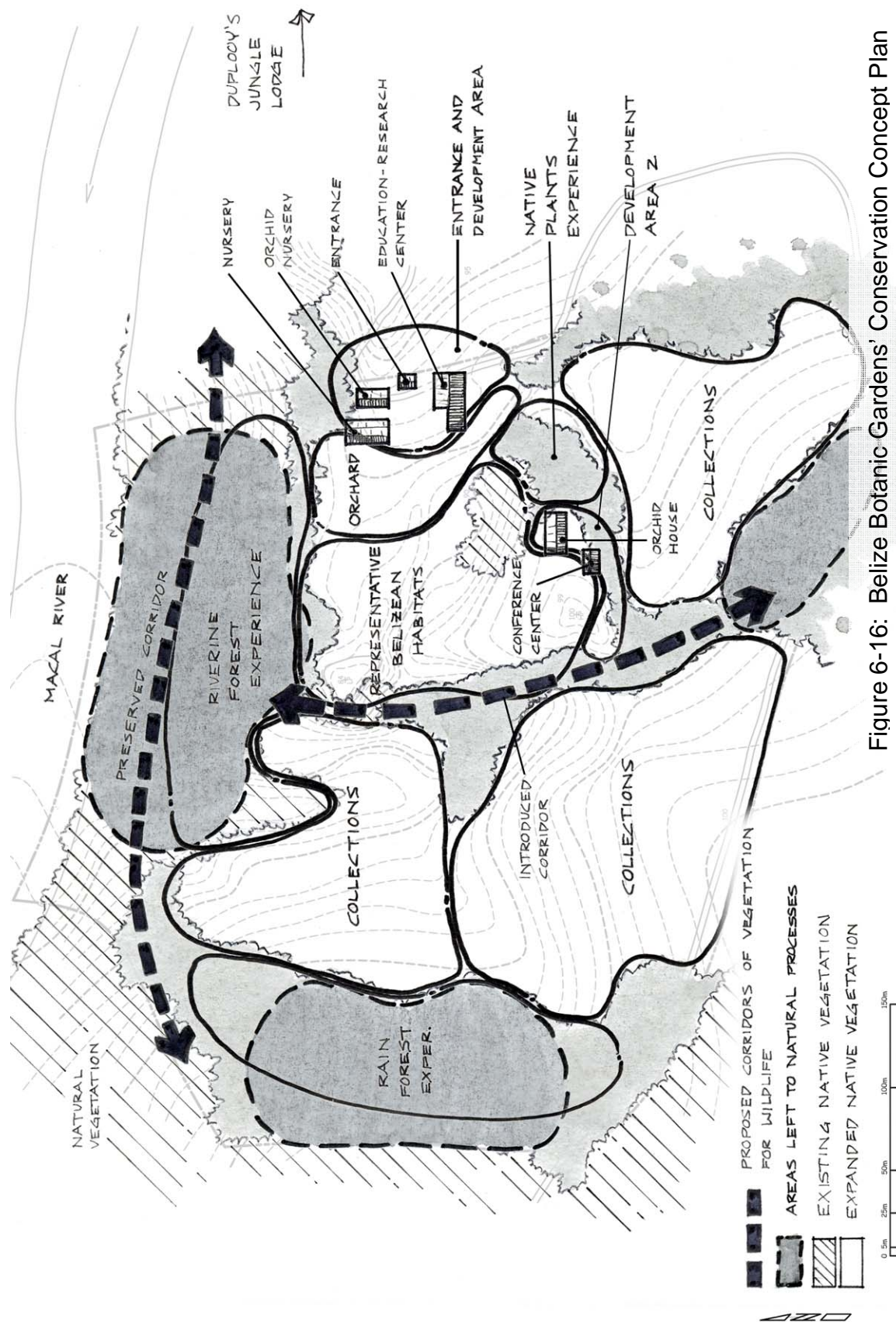


Figure 6-16: Belize Botanic Gardens' Conservation Concept Plan

## CHAPTER 7

## CONCLUSION

The first western botanic garden was founded in Pisa, Italy in 1543 (Heywood 1987) to grow and organize plants for use by medical students. Since then, the purpose and design of botanic gardens have changed to meet changing scientific needs and cultural expectations. Botanic gardens are now being asked to help conserve the earth's biological diversity through research, collections, and education.

Many modern botanic gardens, both new and established, have developed research and education programs that contribute much to the mission of conservation. However, little has been published that directly addresses physical planning and design for conservation within the confines of a botanic garden. This is an oversight. As important as research and collections are, education may ultimately be more important to global conservation efforts because conservation cannot happen without the support of millions of individuals. The garden grounds and physical design will be the part of the garden's operations that most people see, and therefore carry the bulk of the educational burden. Therefore, the planning and design of a botanic garden attempting to focus on conservation should respect and promote the conservation message.

The planning and design guidelines presented in Chapter 5 attempt to correct this oversight by providing a conservation framework within which a

botanic garden can be designed to facilitate public appreciation, understanding, and education. The hypothetical case study in Chapter 6 demonstrates their applicability in planning a botanic garden. If the guidelines are followed, the garden mission and site conditions will guide the planning process. However, the actual effectiveness of the guidelines remains in question.

The guidelines were developed based on information found in the literature about botanic gardens, conservation, and sustainability, and experience gained developing a master plan for Belize Botanic Gardens. As such, they are heavily academic in nature and could benefit from application and verification.

## EVALUATION OF GUIDELINES

This section will attempt to explain the reasoning behind the guidelines and evaluate their effectiveness from an academic perspective. Each guideline will be restated and then followed by the relevant explanation, along with any evaluative comments. The first number on each guideline is the section number. The second is the number of the guideline in that section.

*1-1. Develop a Specific Mission Statement for the Garden carefully spelling out what conservation activities the garden will pursue, and make all design decisions in support of the mission.*

This guideline is very basic, and many publications providing guidance for botanic garden design begin at the mission statement. The only thing added in this work is that the mission statement should state specific conservation

activities. As with any program-driven design, this will help focus decisions and resources on the activities most important to the garden.

*1-2. Allow the site's context and physical features to guide planning and design decisions.*

Again, this is an approach advocated throughout the field of landscape architecture and repeated in the literature on botanic garden design. It can support conservation when it minimizes site disturbance and the destruction of on-site natural systems. Utilizing site features can contribute to a more “natural” and appropriate footprint on the land.

*2-1. Select a site that includes or is near native habitat. Where this is not possible, select a site where such habitat could be easily restored.*

In selecting the site for a botanic garden that will focus on conservation, it makes sense to choose one with or near remnants of the regional vegetation the garden hopes to conserve and display. It would be more difficult and expensive to pick a site where such vegetation would need to be restored from scratch after existing conditions are ameliorated. Of course, there are times when this choice is not available, such as in an urban environment or on a previously degraded site. But barring such situations, a site should be selected that contains native vegetation.

There are at least three shortcomings to this guideline. One, it can be argued that, to be most effective in attracting and educating visitors, a botanic garden should be very near populated areas. Because remnants of native habitat are not as likely to be found near urban areas as they are away from such areas,

this guideline may be inapplicable in some circumstances. Two, locating a botanic garden in an area of native vegetation may do more harm to the natural systems than good. Three, the potential for future urbanization around the garden site and its impact on the garden's mission and functions is not directly addressed.

*2-2. Preserve as much existing native vegetation as possible and make these areas/stands/remnants the planning and organizational foundation, or core, of the garden.*

In any development it is often tempting to remove existing vegetation and change existing topography in order to realize a desired vision. However, in the true spirit of conservation, this guideline encourages botanic gardens to preserve existing vegetation and plan around it. This may not allow for some of the formality and design often associated with botanic gardens, but it does convey a message. In addition, it can create unique spaces and organizational plans that would not be realized following more traditional approaches. As a bonus, native vegetation is more likely than exotic vegetation to attract native birds and butterflies to the site, which could enhance the visitor experience.

*2-3. Look for ways to create or preserve ecological functionality and allow natural processes to occur (as part of the educational mission).*

Ecological functionality typically involves interconnected processes over larger areas than a botanic garden can enclose. Therefore, having truly functional processes in a garden may not be practical due to issues of scale. However, some could be effectively abstracted. Others may be effectively



created, but success is more likely if they are pre-existing on the site and preserved.

Some, such as the natural processes of vegetative succession are comparatively simple to allow and demonstrate. All that is required is to allow plants to grow, die, and be replaced without any human intervention. Others, such as the dynamics of a river or stream could prove disruptive to the garden and its operations. They could also occur too slowly for visitors to comprehend them.

Whatever the method chosen, it is important to show natural processes for two reasons. The first is so that people can see how they work. The second is to demonstrate that change is a constant in nature (Chance 1988) and that man-made institutions can coexist with such unpredictable forces.

*2-4. In support of #2-2, do not relegate areas of native vegetation solely to the outer edges of the garden. If that is where they occur naturally, maintain them there and attempt to pull them into the garden's center (as part of the educational mission).*

This guideline contains some important principles for conservation botanic gardens. Of primary importance is that native vegetation should be a key element of the garden experience, one that people can get close to and experience with all their senses. Native vegetation in a botanic garden could easily be treated as a backdrop against which the "more interesting" collections are displayed. It could also be placed in the furthest reaches of the garden where only the purists will venture. Either treatment is the antithesis of conservation education.

The native vegetation should be front and center and the primary display in the garden. Even though areas of native vegetation may be used to structure the garden, as per guideline #2-2, they can still be major displays and a constant presence. Visitors should have the opportunity to appreciate all their facets.

*2-5. In conjunction with #2-2, maintain or create linkages or corridors of native vegetation through the garden (as part of the educational mission).*

In a regional mix of native habitat and development, properly planned corridors allow flora and, more specifically, fauna, to move from one habitat patch to another. Depending on a garden's location, vegetation corridors may not always be functional. Where they can be functional they should, and maintain connectivity with the larger landscape. However, even where they cannot, they are a good way to illustrate the purpose and value of corridors in the larger landscape.

*2-6. In support of #2-2, 2-4, and 2-5, cluster buildings and major development in order to provide additional area for vegetation.*

Clustering is a well-recognized way to minimize the impacts of development on an area of native landscape and vegetation. In the botanic garden wishing to highlight conservation, clustering is particularly important. It minimizes development and construction impacts within the garden, including the impacts of large equipment, and allows for larger undisturbed areas of vegetation and habitat. With careful planning, this guideline should be easy to apply in most gardens.

*2-7. Where existing vegetation is not native, does not adequately allow full expression of the garden mission, or must otherwise be supplemented, represent the native communities by creating abstractions and simplifications of natural patterns based on authentic regional ecological communities.*

The practice of abstracting native plant communities to represent the real thing has been advocated for many years by landscape design practitioners (Morrison 2004). This practice is particularly relevant in botanic gardens that want to show off native communities and habitats. Even where stands of native vegetation remain, there may be a need to represent habitats not found on the site. In such cases it will be particularly difficult to recreate a complete habitat with all of its complexity. An abstraction can provide the essence of a habitat to help people appreciate its beauty and purpose.

*2-8. Harness the beauty of healthy ecosystems.*

This guideline could be considered more abstract than the others. It is, nonetheless, important. In all the discussion of conservation, it must be remembered that people appreciate beauty. Beauty of some kind is typically what draws a person to nature. If this is left out of the equation, a garden will likely be less successful than if it were included. Healthy communities of native plants can be very beautiful, and a garden should seek ways to highlight that beauty in all of its planning decisions.

*3-1. Showcase native plants in man-made landscapes to show off their utility and ornamental qualities. Specifically, provide display areas that show how*

*native plants can be used in commercial, residential, and public landscapes to replace more traditional exotics.*

The benefit of this guideline to conservation is two-fold. First, if native plants are used more often in man-made landscapes, instead of traditional exotics, the threat of extinction to some native plants may be reduced because they will be prevalent in the landscape and in the nursery industry. Through carefully designed displays, the botanic garden can be the example of such uses of native plants. Second, the use of native plants in man-made landscapes will enhance regional identity and provide more potential habitat for wildlife.

*3-2. Demonstrate culturally appropriate ways to integrate healthy native plant communities with larger scale development.*

The intent here is to explore ways to provide for development while also providing for healthy, functioning native plant communities and ecosystems. Culturally appropriate refers to the fact that cultures have different ideas of form (Treib 1995), space (Leadlay and Greene 1998), and the value of native vegetation (Hitchmough and Dunnett 2004). Ideas for integration should be imagined in ways that the local community will accept and understand.

To show such integration at full scale in a garden may be prohibitively expensive for a botanic garden, both in terms of money and space. However, the principles of integration might be demonstrated on a small scale and the larger application explained through interpretive educational material.

*4-1. Demonstrate a commitment to conservation by using sustainable design principles in all facilities and infrastructure and by following sustainable operational practices.*

Sustainable development, loosely defined as development that protects natural resources, systems, and processes, is an important part of global conservation. In order to be an example of conservation on every hand, the conservation botanic garden must respect the environment from beginning to end. This includes everything from planning to construction to daily operations. Regarding daily operations, the implementation of sustainable practices can be as simple as minimizing or eliminating chemicals and inorganic pesticides.

*5-1. Integrate a conservation storyline into the overall plan and design of the garden.*

This guideline is about helping visitors remember what they see and learn. Stories often help people understand and remember principles. The idea of telling a story throughout a garden is not new (Jones and Hoversten 2004). If the story can introduce and explain conservation in a compelling, interesting way, the garden's mission of teaching people about conservation will be easier. The story does not need to be a narrative, although narratives may often be more effective than the reiteration of a message.

*5-2. Display the garden's mission statement prominently at the entrance, and repeat it throughout the garden.*

Just as the mission statement should have guided the planning and design of the botanic garden, it makes sense that it should guide the visitor

experience. Displaying the mission in the garden introduces visitors to the garden's underlying purpose. It also provides some context for what the visitor is about to experience. This type of context is critical to understanding. An explanation of how the garden's mission fits into the global conservation picture could further enhance understanding.

*5-3. Provide sufficient background information to ensure that an individual display and its message make sense to visitors.*

This reiterates the need for context. One botanic garden, by itself, can do little to effectively conserve biodiversity. Therefore, it is necessary to show how the individual garden fits into a larger global picture. Just as the mission statement gives some context for the garden experience, interpretive information should be backed up by a larger framework that highlights the importance and meaning of each display.

*5-4. Relate the garden's message to visitor's everyday lives so that they take something with them when they leave.*

Even with adequate context and background, the best message will affect nothing if people walk away from the garden without experiencing a changed attitude or learning about something they can change in their daily behaviors to help conserve biodiversity. This can be as simple as getting someone to stop buying unsustainably produced products, or as involved as inspiring them to become active in promoting conservation to others. Either of these outcomes could be promoted in a botanic garden through displays, experiences, and interpretive information.

*5-5. Minimize distances between people and plants to maximize sensory experiences and interaction.*

People tend to get involved in issues that impact them directly, or with which they have personal experience. One way to gain appreciation for biodiversity is to gain appreciation for plants through direct experience. This guideline is intended to help people gain personal experience with plants through sensory contact in the hope that their attitudes and behaviors will change.

### **SUMMARY AND SUGGESTIONS FOR FURTHER RESEARCH**

The guidelines presented in Chapter 5 and reviewed in this chapter were devised based on information found in the literature on botanic gardens, conservation, and sustainability, and from experience gained developing a master plan for Belize Botanic Gardens. As demonstrated in the foregoing evaluation, they seem effective in guiding a garden's high-level planning decisions, and they appear to have promise as one way to promote conservation. However, they are heavily academic and could benefit from application and verification.

Therefore, one suggestion for further research is to implement some of these guidelines in a botanic garden and evaluate their applicability and true effectiveness. A follow up study on visitor perceptions of the implementation would be very beneficial.

Some of the guidelines assume that the actions suggested are practicable. They may not all be. It would be beneficial, for instance, to find out which ecological processes could be represented on the scale of a botanic garden, and then determine how best to represent them.

A sample landscape design for a man-made setting that uses all native plants might also be useful. So too would be guidelines on the aesthetic, ecological display of native plants in the setting of a large garden.

Finally, the guidelines presented herein are largely geared toward implementation in a new botanic garden in a rural setting. It would be interesting to see an adaptation of these guidelines to an existing botanic garden and/or to a decidedly urban botanic garden.



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APPENDIX  
**A DESIGN MASTER PLAN FOR BELIZE BOTANIC GARDENS**



**A Design Master Plan**  
for  
**Belize Botanic Gardens**  
San Ignacio, Cayo District, Belize

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## Table of Contents

Garden Philosophical Background .....	124
Analysis of Garden Collections, Layout, and Potential .....	124
Current Collections .....	125
Current Layout .....	125
Challenges .....	126
BBG's Potential .....	126
Proposed Garden Areas .....	127
Recommended Interpretive Displays .....	139
Design Guidelines .....	141
Trails and Circulation .....	141
Trail Hierarchy .....	141
Trail Treatments and Material Guidelines .....	141
Intersections .....	143
Signage .....	149
Directional Signs .....	149
Locational Signs .....	153
Interpretive Signs .....	153
Sponsorship Signs .....	155
Plant Identification Tags .....	156
Structures .....	156
Buildings .....	156
Walls .....	158
Plantings .....	159
Continuity .....	159
Balance .....	163
Spatial Hierarchy .....	166
Ecological Planting Design Principles: Habitats .....	167
Basic Planting Design Principles .....	167
Plantings Conclusion .....	168
Phasing .....	170
Implementation Phases .....	170
Phase 1 .....	171
Phase 2 .....	171
Phase 3 .....	171
Phase 4 .....	171
Conclusion .....	172
References .....	173
Appendix: Dimensions .....	174

## **Belize Botanic Gardens Master Plan**

### **Garden Philosophical Background**

When Belize Botanic Gardens (BBG) was founded, the owners established a goal and a purpose statement to guide the garden's development. BBG's founding goal is: "To protect the terrestrial biodiversity of Belize and the watershed of its coastal reefs" (Belize Botanic Gardens NA). Its purpose is: "To establish an institution that will lead efforts to protect, conserve, study, and disseminate information about the flora of Belize" (Belize Botanic Gardens NA).

The founders then developed the six supporting goals that follow, which they called "project outputs" (Belize Botanic Gardens NA).

- 1) Establish an education program to increase awareness of conservation and the sustainable use of Belizean flora.
- 2) "Establish a program of conservation activities focused on Belizean plant biodiversity.
- 3) "Establish a program of research in tropical plant conservation.
- 4) Develop the sustainable agriculture of alternative crops which are compatible with the native Belizean flora.
- 5) "Establish the infrastructure needed to support programs in education, research, conservation and sustainable agriculture.
- 6) Manage the garden efficiently and distribute new information yielded by the garden's work.

Careful review of these goals makes it clear that a great deal of thought has gone into BBG's *raison d'être*. A visit to the garden and conversations with garden staff show that BBG is actively engaged in many of the activities and programs set forth. The design master plan supports BBG's founding goals, current programs, and future expansion. Their biggest needs are for an improved circulation system to simplify visitor orientation, standardized design guidelines, enhanced interpretive information, and better delineation of collections.

### **Analysis of Garden Collections, Layout, and Potential**

The first step in creating this design master plan is to analyze the current state of Belize Botanic Gardens. There is very much that is good in the garden that should be preserved. There are existing programs and activities that should be accommodated. There are existing structures that cannot be feasibly moved and must be protected and accommodated.

That said, changes that may improve the visitor experience and garden operations should not be ignored simply because they will entail a great deal of effort or expense. The following is a long-range master plan, with the intent that proposed changes will be implemented gradually over a number of years as time and funding permit.

## CURRENT COLLECTIONS

BBG currently has a wide variety of collections ranging from native habitat displays to a fruit orchard. Due to the site's natural conditions (soils and rainfall), previous uses (cattle pasture), and the amount of maintenance required, some collections and displays are more successful than others. According to BBG's website and on-site visits, the current plant collections and attractions are (Belize Botanic Gardens 2008b):

- Agroforestry demonstration
- Bamboo arch
- Bay leaf palm project
- Conference center
- Fruit orchard
- Hamilton Bird Hide
- Heliconia Lane
- Inland lagoon habitat
- Mountain pine ridge habitat
- Native Orchid House
- Palms of Belize
- Plants of the Maya / Maya House
- Rainforest
- Riverine forest
- Savanna habitat
- Vine pergola
- Xate project demonstration

BBG's founders selected five representative habitats from Belize. They selected these habitats because they represent the core habitat types found in Belize, of which all other habitats are variants (duPlooy 2007b). The selected habitats are savanna, mountain pine ridge, native water areas (pond), riverine forest, and rainforest (Belize Botanic Gardens 2008b; duPlooy 2007b). In course of time, they have added a sixth habitat, that of littoral edge.

BBG has elements of an ethno-botanic garden as described by Jones and Hoversten, such as examples of plants used by indigenous peoples and the objects made from them (Jones and Hoversten 2004). However, ethno-botany is not their primary focus. It is included to connect the present with the past and to suggest the potential importance plants have to the future of the human race as part of an overall mission of promoting conservation and sustainable use of earth's resources. They recognize that sustainability is largely dependent on the relative prosperity of local peoples. Ethnobotany can be about preserving and remembering the past in a living museum (Jones and Hoversten 2004). Conservation is really about the future.

## CURRENT LAYOUT

As a garden, BBG has two major sections: the inner garden and the outer garden. The inner garden is focused more on showy plants and is the intended location of most of the designed displays. The outer garden is more naturalistic and contains most of the habitat displays.

The garden's trail system is a mixed bag. Many trails are well-maintained, and many are picturesque and very enjoyable. Others, however, are difficult to find, rocky, and hard to use when wet. Not all areas of the garden are accessible by trail. The overarching shortcoming of the trail system is that it doesn't improve visitor navigation, and in some cases hinders it. For example, there is no trail from the entrance into the garden. Upon entering the garden, the first trail seen is a service road about 20 feet away. Trail construction includes mowed swaths through the grass, ruts left by service and other vehicles, bare dirt, and wood chips.

BBG's collections and facilities are placed to take advantage of topography as well as shade and sun. Some collections have suffered due to their placement, such as the Savanna habitat display. It lies at a low point in the garden and receives runoff from the surrounding hills containing soils too alkaline for the Savanna plants. From a visitor perspective, the collections are sometimes hard to distinguish from their surroundings. This is not always a negative. The naturalistic feel of the garden highlights the beauty of a more natural setting.

The current layout lacks a strong sense of unity. Habitat displays are dispersed throughout the garden.

## **CHALLENGES**

Because BBG is off the beaten path, it is a destination more than a side-trip. The main visitor access to BBG is by way of a four-mile long dirt road. Parts of the road are very steep, often too steep for small cars, and parts can be rutted and rocky. These factors can make getting to the garden something of a challenge.

However, the drive to the garden provides an opportunity to highlight the garden's work as an alternative to traditional land-use patterns. The visitor will pass a number of farm fields and vacation resorts on this road. Many of these are somewhat open and bare looking, and contrast with the rich vegetation coverage at the garden.

Another challenge is insufficient funding, which leads to a staff that is not large enough to maintain and improve the garden. It also limits the extent and variety of improvements the garden can implement.

Related to funding, the garden is a high-maintenance facility. Due to the rapid growth rate of the vegetation, maintaining trails and keeping collections within bounds is more than a full-time job. As a result, not all trails are open at all times.

## **BBG'S POTENTIAL**

BBG is at a turning point in its development. Garden owners and staff have the opportunity to mimic what has been done in other botanic gardens or to make a statement about what makes BBG unique. The foundation is set for a useful and productive life for the gardens. It is hoped that the recommendations in this master plan will add to the garden's mission of education and conservation by making Belize Botanic Gardens more accessible to its thousands of annual visitors and thereby more enjoyable.

The guiding principles for what follows are to enhance conceptual and mental accessibility; to increase visitor comfort and safety; to respect the rustic, natural feeling garden visitors currently enjoy; to leverage the abilities of garden staff in all proposed work, in order to reduce costs; and to reduce regular maintenance.



will enhance the value of this display as a demonstration because it will show more than just the concept.

To this end, BBG will plant mahogany, teak, cedars, zericote, and paulo blanco, among others, because they are appropriate for the climate and ecology of Belize and because they have a high market value. Legumes will also be planted because they require a shorter period from planting to harvest and will allow for some profit while the other trees are young and the area is not shaded out (duPlooy 2007a).

In keeping with the garden's commitment to use only organic management methods, Neem trees, which act as a natural pesticide, may also be planted. These can be harvested for use as a pesticide/fungicide (duPlooy 2007a). In a commercial agroforestry operation, the detritus from the cultivated trees could be used as fertilizer or food for livestock.

### **Bamboo Arch**

An arch formed of giant bamboo (*Bambus bambos*), the world's largest, to illustrate the beauty and utility of this versatile plant. Because bamboo grows quickly and is dense and strong, it is an ideal sustainable alternative material for construction, scaffolding, paper making, screens, flooring, and numerous other uses (duPlooy 2007a). To illustrate this point, bamboo is used in garden buildings.

In addition, this living arch provides deep shade and makes a great place to relax.

### **Bay Leaf Palms**

The Bay Leaf Palm (*Sabal maritiformis*) is native to Belize. It is used extensively by Belizeans, refugees, and the tourist industry to create thatch roofs (Belize Botanic Gardens 2008c). Because of its extensive use, the plant is becoming rare in the wild, compounding unsustainable gathering practices (Belize Botanic Gardens 2008c). To help maintain the existence and health of wild populations, BBG is experimenting with growing and propagating Bay Leaf palms (Belize Botanic Gardens 2008c).

The Bay Leaf Palms collection has many purposes. One is to allow farmers to observe growing techniques and production levels. Another is to demonstrate how sustainable Bay Leaf Palms can be in Belize. It is in its natural environment and therefore needs little to no irrigation or pest control. It grows under a natural forest canopy, which will reduce the need to clear land. BBG staff can harvest seeds for distribution or sale to interested farmers and producers. Finally, a market for the crop already exists.

BBG has found that about 1000 specimens may be planted per acre, and at least 2 leaves may be harvested per plant annually. At a sale price of \$0.50 to \$1.00 per leaf, one acre could yield \$2,000 a year with minimal inputs and no replanting (duPlooy 2007a).

### **Birds & Bats Garden**

Funded by a grant from the Stanley Smith Horticultural Trust, the birds and bats garden will comprise a collection of native plants that are useful to Belizean birds and bats. BBG has a unique opportunity to attract and re-attract animal life to the area, and this effort contributes to that goal. In doing this, BBG can show visitors the importance of including native plants, which are attractive and necessary to wildlife, in landscaping. Gardens with native species are of increasing importance as natural habitat disappears

and animal species become dependant on human altered-habitats to provide the shelter and food they need (duPlooy 2007a).

### **Blue Palms Display**

A beautiful display of Blue Palms (*Bismarkia nobilis*) that is particularly impressive from the conference center. This display occupies a south-east facing slope in the garden, and can be enjoyed from above at the conference center or from within on the road.

### **Buffer Space between Forest and Bamboo**

This is a small unprogrammed space between the Bamboo Arches and the Wet Hardwood Forest intentionally left unplanted to keep the bamboo from invading the forest area.

### **Cohune Palms**

An impressive display of Cohune palms, which are a culturally significant tree in Belize. All Belizeans probably know and use Cohune palms at some point (duPlooy 2007a). They extract oil from the nut, carve the nut into crafts for sale, use the wood in construction and carving, and use the leaf for weaving and thatch (duPlooy 2007a). The nut is also used to make a high-grade charcoal which was used in gas masks during WWII (duPlooy 2007a).

In addition, Cohune palms withstand milpa (slash and burn) farming and move in quickly after a disturbance. Because of this they are common on Belizean ridges and in areas previously cleared for farming or grazing (duPlooy 2007a).

### **Craft Plants Area**

Throughout the world, plants have been and currently are used by humans for clothing, shelter, utensils, crafts, and arts, and are therefore a part of the economies of most cultures (duPlooy 2007a). The Craft Plants Exhibit showcases non-timber forest products (NTFP) which are the plants most commonly used by people for the above-mentioned purposes (duPlooy 2007a). Visitors are provided instruction and the opportunity to use some of the plants to make their own crafts.

Because of the declining health of forests worldwide, largely due to a combination of factors including poor harvesting practices, the lack of cooperative forest management between governments and local peoples, and harvesting plants for sale to non-local markets, many NTFP plant species are threatened (duPlooy 2007a). This exhibit will help BBG educate people about these issues.

### **Cycads**

Cycads are one of the oldest plant families, having co-existed with the dinosaurs, and were the first plants to evolve from reproducing via spores to reproducing via cones (duPlooy 2007a). Cycads are highly sought after by collectors which, combined with habitat loss, has resulted in the fact that all species of cycad are threatened in the wild. All cycad species are protected under the Convention on International Trade in Endangered Species (CITES) (duPlooy 2007a).



This exhibit allows BBG to display these unique plants and educate people about the issues surrounding them.

### **Entrance / Native Plants Display Garden**

The main garden entrance will provide a formal entry experience and a gathering area showcasing native plants. Funded in part by a grant from the Stanley Smith Horticultural Trust the entrance showcases Belizean plants in designed landscape settings.

One way to preserve local biodiversity and character is by using native plants in landscaping, whether in front of one's home or in public spaces. BBG can inspire Belizeans to do so through attractive demonstration gardens of native plants, as has been done in other places (Jordan Valley ND). Gardens with native species are of increasing importance as natural habitat disappears and animal species become dependant on human altered-habitats to provide the shelter and food they need (duPlooy 2007a).

### **Figs Display**

This area will eventually display three mature fig trees. The varieties chosen grow to be massive trees requiring a great deal of space. They have a unique relationship with the wasps that pollinate them (duPlooy 2007a). Some species have aerial roots that grow down from the branches and into the ground, increasing the tree's girth. These features make them interesting to people. The figs themselves are useful to insects, birds, and lizards (duPlooy 2007a).

### **Forest Edge**

The forest edge is an interesting ecotone, and BBG has a number of opportunities to showcase its plant life and diversity. Forest edges in Belize look impenetrable from the outside, but they are in reality only a few meters thick. The forest inside is largely open from the floor to the canopy.

In BBG, these habitat displays are located to provide the most dramatic visitor experience. Visitors will be able to see the thick vegetation from the outside, they will be able to pass through that vegetation, and then experience the relative openness of the forest interior. This highlights the way a variety of habitat types contribute to biodiversity, and the need for patches, edges, and open spaces in natural landscapes.

### **Founder's Memorial: Africa Hill**

Location of Ken duPlooy's grave. Ken, who was born in Zimbabwe, founded BBG. This memorial attempts to display some of the plants from Ken's native land.

### **Future Expansion**

BBG has more land than they currently need, and more than they can adequately maintain. This is good because it provides them with room for future growth.

### **Heliconia & Coffee**

"BBG boasts a complete collection of Belize's heliconia and ginger as well as over 50 different varieties from the world's tropics" (Belize Botanic Gardens 2008b). The

Heliconia & Coffee exhibit provides a home for many of the garden's *Heliconia*, as well as gingers, *Strelitzias*, and aeroids. These plants typify the tropics (Belize Botanic Gardens 2008b), and a walk through this area is a concentrated tropical experience.

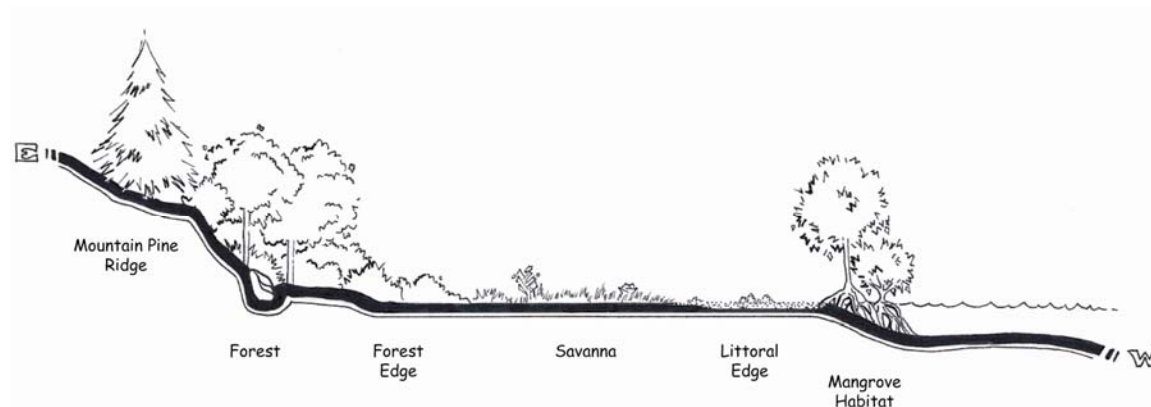
This showcase of beautiful and showy plants can inspire in visitors an appreciation of the beauty of the natural world. Interpretive information for the coffee exhibit encourages people to look for Fair Trade products wherever possible (duPlooy 2007a).

### Littoral Edge

Part of the effort to highlight underappreciated Belizean habitats, the Littoral Edge display is principally an educational opportunity. The littoral forests of Belize often coincide with development and tourist activities. As such, they are often modified or degraded. BBG's display describes the functions of a healthy littoral habitat and offers a comparison between what such a habitat should look like with what they often look like today on the coasts of Belize.

In nature, littoral forests are typically bordered by low herbaceous vegetation on the seaward side and by mixed mangrove scrub on the inland side (Meerman and Sabido 2001). To suggest this relationship in the garden, the Littoral Edge habitat is adjacent on one side to the Sunken Garden, which will contain water and provide the opportunity for mangrove plantings. On another side, the Littoral Edge habitat is adjacent to the Savanna. While littoral forests do not normally occur next to savanna habitats in nature (Meerman and Sabido 2001), savannas are one of the next habitats encountered in Belize when moving inland from the sea. The arrangement of these habitats in the garden will help convey the concept of habitat connectivity.

The potential habitat continuum that begins with the Littoral Edge is illustrated in Figure A-2.



**Figure A-2: Abstracted Belizean Habitat Continuum as Proposed for Display at BBG**

### Managed Hardwood Regrowth Forest

Part of a two-part hardwood forest, this area demonstrates the effects of managed planting on the reclamation of forest from cattle pasture. As mentioned in the garden history, the property was cleared cattle pasture when the duPlooy's purchased it. This area

was re-planted on a regular grid with native hardwood species that would be found in the rainforests of Southern Belize along with appropriate underbrush (duPlooy 2007a). Walking through this area, visitors can see how quickly the forest can recover if helped along.

The intent of this area is to help people appreciate the diversity of the rainforest and experience some of the unusual, useful, and attractive plants found in the rainforests of Belize (duPlooy 2007a).

### **Maya House / Maya Plants**

The Maya House exhibit pays tribute to the Mayan heritage of Belize. Historically, the Mayan population of Belize was larger than the country's current population, and there are many ruins around the country that bear witness to this fact.

The Maya House is an example of traditional Maya building techniques. The plants around the house exemplify those the Maya used in their daily lives. This area is the central point for a walking tour through much of the garden in which plants used by the Maya are highlighted.

Many of the plants used by the ancient Maya are used for similar purposes by modern man. Protecting these plants and their habitats may have future benefits for all of humankind.

### **Mountain Pine Ridge**

This exhibit introduces visitors to the mountain pine ridge habitat and fire dependent habitats of Belize. It includes a fire tower, similar to those used in the mountain pine ridge preserve, from which visitors can overlook the gardens and surrounding countryside.

In Belize, pine habitats naturally occur most frequently at higher elevations (500-1000 m) and have a broadleaf component (Meerman and Sabido 2001). In BBG's abstracted representation of Belizean habitats, the Mountain Pine Ridge is located at one of the highest points in the garden and represents the opposite end of a continuum that begins with the water in the Sunken Garden, representing the sea. Having the Unmanaged Regrowth Forest between the Mountain Pine Ridge and the other habitats presented in the garden mimics the rain forests that would separate pine habitats from savanna and other habitats in nature. These concepts are illustrated in [Figure A-2](#).

### **Mountain Pine Ridge 2**

This companion exhibit to the Mountain Pine Ridge habitat is intended as a visual extension of the pine ridge, to be seen from the top of the fire tower. The effect should be one of extending the pine forest beyond the immediate surroundings of the Mountain Pine Ridge exhibit.

### **Native Butterfly Garden**

Funded in part by a grant from the Stanley Smith Horticultural Trust, the butterfly garden will provide the flowers, plants, and other resources native butterflies use during their life cycles. Currently, butterflies can be seen throughout the garden. Focusing this

area on butterflies and the plants that attract them will create a constant spot of life and color, and will likely increase the presence of butterflies throughout BBG.

In doing this, BBG can show visitors the importance of including native plants, which are attractive and necessary to wildlife, in landscaping. Gardens with native species are of increasing importance as natural habitat disappears and animal species become dependant on human altered-habitats to provide the shelter and food they need (duPlooy 2007a).

### **Native Hardwoods Buffer**

This stand of native hardwoods serves a number of purposes. First, it creates a beautiful, full buffer and transition between the pond and the Maya House. Second, it shows respect for the natural vegetation communities of the site, draws them into the garden, and uses them as structural elements and backdrops. Red Butte Gardens in Salt Lake City, Utah has done something very similar by using the native Gambel Oak, which is indigenous to the site, as the dominant backdrop plant for many of its collections. Third, it partially encloses the Maya House and pond displays.

### **Nursery & Work Area / Staff Area / Plant Sales**

Much of the behind-the-scenes work at BBG takes place in and around the nursery. This is where plants are propagated and held for planting, where supplies and tools are stored, and where plants are nurtured. The nursery is sited where it is to take advantage of level ground, proximity to the main road for service vehicles, a mix of sun and shade, and proximity to the entrance. Being in a corner helps keep it tucked away from visitors.

That said, the nursery and work area will be moved further away from the garden entrance so that it is not the first thing visitors see upon entering the garden. The two will be buffered by a dedicated plant sales area. Currently, the plant sales area shares space with the nursery.

The nursery & work area will eventually contain a small “complex” consisting of a staff room with shower, latrine, dining area, and library. The space is designed to accommodate, in an efficient manner, the different activities that will take place there.

### **Open Grassland**

Through observation, garden staff have noticed that the numbers of birds and other wildlife in the garden increase when open, un-mowed areas of grass remain, because the animals are attracted by the grass seeds. To encourage the continued presence of large numbers of animals in the garden, the northwest corner will be maintained as open grassland, managed to produce a continuous seed crop from stands of varying ages.

In the first part of 2007, this area of the garden was populated by an invasive grass species. If suitable species exist, BBG should replace the invasive species with non-invasive natives to prevent the uncontrolled spread of the grass and reduce maintenance.

### **Open Ridge**

This area will be kept free of undergrowth and dense canopy plantings to contrast with the palmetum to the west and the cohune palms display to the east. The effect will be that of a gallery between the two areas, permitting views into the palmetum.

### **Open Space**

The open spaces located throughout the garden are intended to provide relief from the dense plantings in other areas of the garden. They are also planned to create and preserve views from one area of the garden to another. Where applicable, they provide distance between paths and collections so that the latter can be appreciated on a more macro scale.

The title “open space,” however, does not infer the absence of plantings. Plants may be placed in these areas as deemed appropriate by garden staff, in keeping with the goals of spatial relief and view preservation.

### **Orchard**

One of BBG’s primary goals is to develop sustainable agricultural crops with economic potential for Belize. They define “sustainable” in this context as agriculture that uses no pesticides or chemicals and that benefits both farmers and nature (Belize Botanic Gardens 2008d). The orchard is one aspect of this goal. In the orchard, BBG staff cultivate a wide variety of fruits ranging from the more common bananas and citrus, to the more unique lychee and mangosteen. Their goal in the orchard is to show that a variety of fruits with commercial value can be grown successfully in Belize. The orchard also demonstrates multi-cropping, as opposed to monocropping, and the diversity of plant life in the tropics (duPlooy 2007a).

The strong formal design of the orchard serves at least three purposes. First, the regular rows and spacing facilitate maintenance and access. Second, it allows this area to do double duty as an entrance, giving visitors a strong impression that they are entering a special, organized place. This entrance and exit experience may be the memory that persists in visitors’ minds as they form, respectively, the beginning and the end of BBG’s “story” (Jones and Hoversten 2004). Third, it demonstrates that fruit production can be mixed with other uses typically seen as more aesthetic, an application that could be used on resorts and public property.

### **Orchid House**

The Orchid House is a beautiful showcase for BBG’s native orchid collection, one of its most popular and important collections. The collection contains many of the 300 orchids known to grow wild in Belize. BBG’s work with Belizean orchids has resulted in the recording of 20 orchids previously unknown to exist in Belize, as well as one previously unknown to science (Belize Botanic Gardens 2008e).

Orchids provide beauty as well as useful substances such as vanilla. Like many other plants worldwide, they are threatened by habitat loss.

### **Palmetum**

BBG's expanding palm collection will be located here. It will eventually include all 40 palms from Belize and palms from other tropical areas of the world, including threatened Cuban palms (duPlooy 2007a). Many palm species are in fact threatened by human exploitation. In addition to being the quintessential tropical plant, palms have great economic value because most people use palms or palm products in some way in daily life (duPlooy 2007a). It is therefore important for BBG to represent the palm family (duPlooy 2007a).

### **Picnic Area**

The picnic area will provide a place for people to linger. Its location takes advantage of large, mature trees that provide thick shade and an open under story. It is located close to the play area so that families can enjoy a picnic and children can play while parents relax within view. This area will also accommodate school groups and give them a place to eat as a group.

### **Play Area**

BBG hosts a large number of children each year as members of school groups that come to the gardens for tours. The play area will provide a place for children to burn off extra energy and relax after a day of educational programming. This area will include a field for running games and sports. It is located next to the picnic area for the convenience of teachers and parents. BBG hopes to attract more families to the gardens.

### **Pond and Native Plants**

The man-made pond is the backdrop to a collection of native water and wetland plant species and serves to attract water-loving birds. Because it is a small space, there isn't room to show all the complexity of Belizean wetlands. However, it does provide an opportunity to abstract such habitats and to educate visitors about them.

### **Reception / Conference Education Area**

This area is located on a gentle rise that has been leveled at the top. A vine-covered pergola and rustic-looking conference center crown the rise. The area is used for wedding receptions, conferences, and other events.

### **Riverine Forest**

Not all tropical forests are the same. Those found along the banks of rivers differ in species composition from inland or upland forests. This area of the garden rises sharply from the banks of the Macal river about 100' in elevation. Walking the undulating trail, visitors experience an authentic river-side forest. They can later compare the experience with that of the hardwood forests on site.

More importantly, healthy riverine forests are critical for preventing the erosion of river banks, which leads to habitat loss, water quality degradation, and land degradation. Even though it is illegal in Belize, many owners of riverside property clear the vegetation on river banks in order to access the river. This display, especially with its ravines and

slumps, can help educate visitors about the important role such forests play in maintaining bank stability.

### **Savanna**

In Belize, savanna is generally seen as wasted land and subsequently undervalued. In reality, it provides a variety of important ecological services (duPlooy 2007b). Because of these two facts, BBG feels it important to showcase savanna habitat in the garden. This exhibit will illustrate the essence of Belizean savanna by including the dominant, abundant, and/or most recognizable plants of that habitat. It is located on mostly level but gently sloping land, sited to take advantage of good drainage and an open south-western exposure.

Short-grass savannas are found naturally in Belize on the coastal plains and are often adjacent to broadleaf lowland forests (Meerman and Sabido 2001). The location of the Savanna habitat in the garden adopts the adjacent open space to the west, effectively transitioning into the Forest Edge and Unmanaged Regrowth Forest. The relationship of the Savanna to the Littoral Edge in the garden helps convey the concept of habitat connectivity. While savannas do not normally occur next to littoral forests in nature (Meerman and Sabido 2001), they are one of the next habitats encountered in Belize when moving inland from the sea. These relationships are illustrated in [Figure A-2](#).

### **Sensory Garden**

As part of its focus on sustainability, and by extension conservation, BBG understands the need to help visitors experience the wonder and pleasure that plants can provide. As more people appreciate the many things plants have to offer, more of us will be inclined to help protect and preserve nature. One way of doing this is to provide a venue for the sights, smells, tastes, and textures of plants. The sensory garden is that venue and plants in this area will be chosen on their ability stimulate visitor's senses. The focus will be on providing a tactile experience that will engage young visitors and visitors with visual impairments.

### **Shade/Zen Garden**

Belize is typically a hot and humid country. BBG visitors will do a lot of walking and hopefully a fair bit of learning. Spots to sit and contemplate are needed. The shade/Zen garden will provide such a place.

The Zen garden is located to take advantage of the almost constant shade provided below the Orchid House. Shade-loving plants and Zen elements will be combined for the visitor's enjoyment. This site has the potential to provide a physical manifestation of the mental enclosure necessary for proper meditation. The minimalist potential of the area will provide a contrast to the complexity and detail of the other parts of the garden.

### **Shrubbery or Mixed Border**

This display is an opportunity to show how local, native plants might be used in a traditional mixed border. Native plants will be combined with other perennial and herbaceous plants. It is hoped that visitors will see the beauty of the plants around them

in a new light, as well as that such traditional landscape elements as a mixed border do not need to contain only traditionally-used plants.

### **Spiny Succulents**

This is a display of euphorbs and spiny succulents. Some of the species displayed here are native to Belize. However, the primary purpose of this display is to show the unique adaptations of these plants with spines (modified leaves) and succulent stems that retain moisture in arid regions (duPlooy 2007a).

### **Succulents Terrace**

The succulents garden will, of course, contain native Belizean succulents, but it will not be a wholly-native collection. It is sited to take advantage of the display possibilities of the slope connecting the Orchid House and the Conference Center. Because these plants are often small, visitors will have the opportunity to examine them up close as they ascend the hill.

### **Sunken Garden**

The intent of this area is to create an ornamental garden, incorporating water, that creates an intimate space. Visitors will be able to descend into this sunken garden to relax in secluded, private settings off the main path, hidden from outside view.

### **Tropical Conifers Collection**

This area is set aside for a collection of tropical conifers. Currently, conifers are not adequately represented at BBG (duPlooy 2007a). The conifer foliage will create an attractive contrast against the broadleaf foliage surrounding this display.

### **Unmanaged Regrowth Forest**

The second part of the two-part hardwood forest, this area shows how the forest will return after a disturbance such as cattle-grazing is removed, with no additional management. BBG staff use the area to observe how species will return without management. Visitors can compare this area with the Managed Hardwood Regrowth Forest on the south side of the trail.

### **Vegetative Buffers & Screens**

A number of planting masses are located throughout the garden to serve as buffers and screens between areas and uses. These largely unmanaged (except to keep them within bounds) patches of native vegetation will form the walls of larger garden spaces and rooms and serve as transitions between them.

If properly arranged, they may also serve as wildlife habitat corridors, bringing more animals further into the garden. In order to do this, patches must be located close enough together and frequently enough that animals will use them.

One buffer/screen of special importance is located in the southeast corner of the garden. This area, while relatively large, screens the garden interior from the road that runs along its border.



**Wildflowers & Scrub**

This collection borders the south edge of the *Heliconia* collection, the north edge of the reception area, and the west edge of the succulents terrace. It helps define each of these other areas. Its trees and shrubs form a good backdrop for showing off native Belizean forbs.

Forbs in Belize do not have a regular blooming season as is common in the northern hemisphere. The flowers in this display will bloom independently throughout the year.

**Wildflowers & Scrub Buffer**

Using wildflowers and scrub as a screen in this location will keep visitors from driving their cars up onto the flat area by the pergola. It will provide year-round interest. It may also serve as part of a corridor wildlife can use to move through the garden.

**Xate Demo**

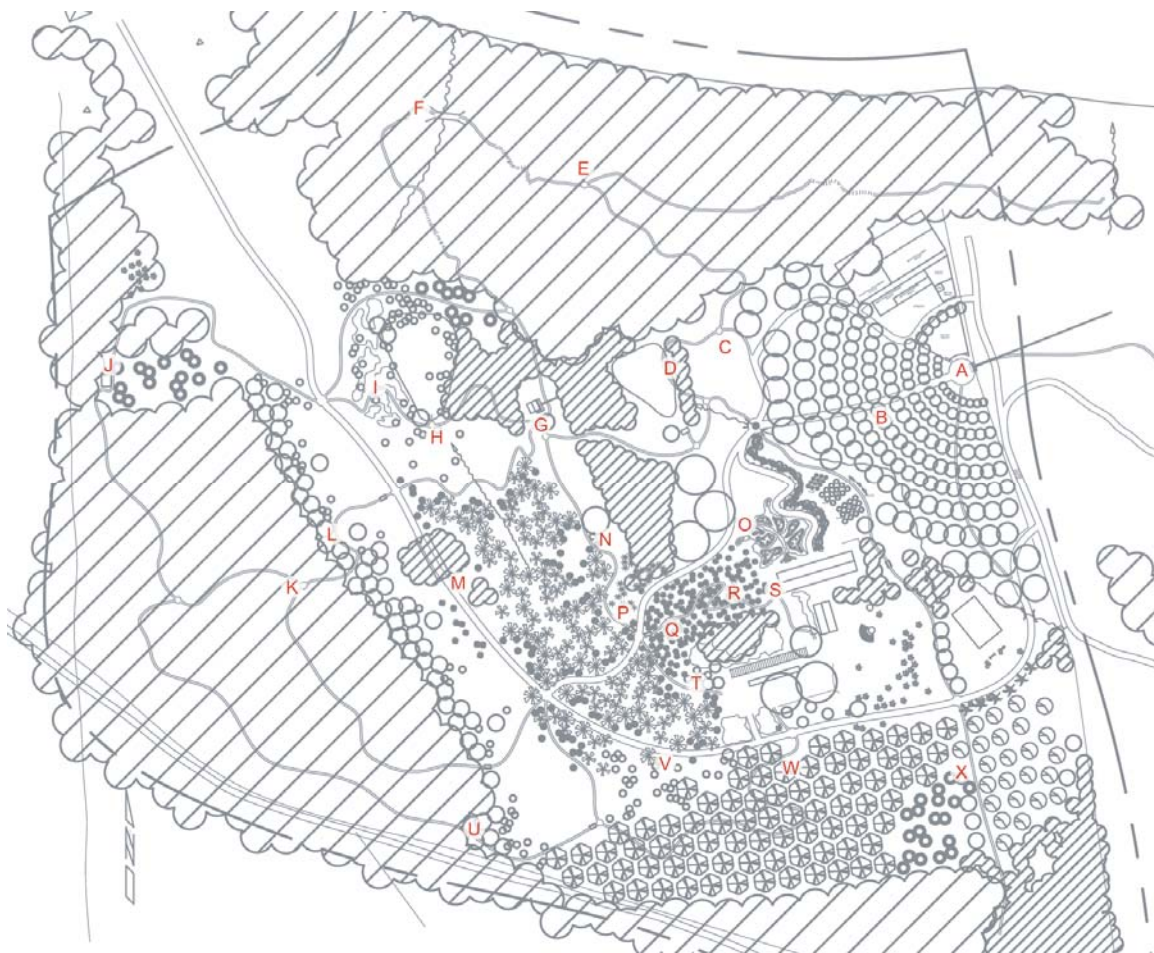
BBG is conducting an off-site experiment with the cultivation of *Chamaedorea* palm species known collectively as xate. This small display in the garden shows visitors what xate is, explains why it's so important, and introduces them to the experimental project. Interpretive information gives the history of the xate project and its current status.

### Recommended Interpretive Displays

Interpretive displays can play an important role in a botanic garden. If done well, they can enhance the visitor experience and promote learning. Poorly planned, they can appear as afterthoughts.

Historically, BBG has used interpretive information as a revenue source by giving people the opportunity to hire a garden guide or purchase a guidebook. Interpretive displays have been few. There is so much going on at BBG that, without relevant displays, visitors who do not purchase a guide will miss the largest part of what is truly important in the garden.

Adding comprehensive on-site interpretive information is not likely to reduce the amount of revenue BBG receives through the aforementioned avenues. Many visitors will still prefer the personal and unique experience of a guided tour. But with appropriate interpretive displays, many more will walk away understanding the value of BBG and its mission.



**Figure A-3: Suggested Interpretive Display Locations**

The following key for the recommended locations of interpretive displays corresponds to the map in [Figure A-3](#). Displays are located to maximize the educational experience of visitors.

<b>Key to Figure 3</b>	
A	Entrance and Native Plants Display Garden—Garden Map, History, and Purpose; Explanation of native plants
B	Orchard
C	Sensory Garden
D	Pond and Native Plants
E	Riverine Forest
F	River—importance of river, its fragility, and the impact adjoining land uses have river quality
G	Maya House/Maya Plants—explain Plants of the Maya trail
H	Savanna
I	Littoral Edge
J	Mountain Pine Ridge
K	Managed Hardwood Regrowth Forest / Unmanaged Regrowth Forest—putting interpretive information for both in same place may heighten the comparison
L	Forest Edge
M	Bamboo Arch
N	Palmetum—combined with Palms of Belize Display
O	Native Butterfly Garden
P	Xate Demo
Q	Heliconia
R	Coffee
S	Orchid House
T	Cycads
U	Birds & Bats Garden
V	Craft Plants Area
W	Agroforestry
X	Tropical Conifers Collection

Other miscellaneous interpretive opportunities that would hold interest for many visitors if explained might include:

- Graywater Garden
- Termite Nests

## Design Guidelines

Design guidelines are important to a botanic garden because they (1) streamline future design decisions, (2) establish the institution's "way of doing things," and (3) help ensure a cohesive experience for the visitor, which can assist in way-finding and comprehension.

The following Design Guidelines for Belize Botanic Gardens are recommended to provide the aforementioned benefits to BBG owners and staff.

## TRAILS AND CIRCULATION

### Trail Hierarchy

A hierarchy of trails, wherein trails of a particular size and type are always used for the same purpose, assists with visitor navigation of the garden. Four types are recommended for BBG's trail system.

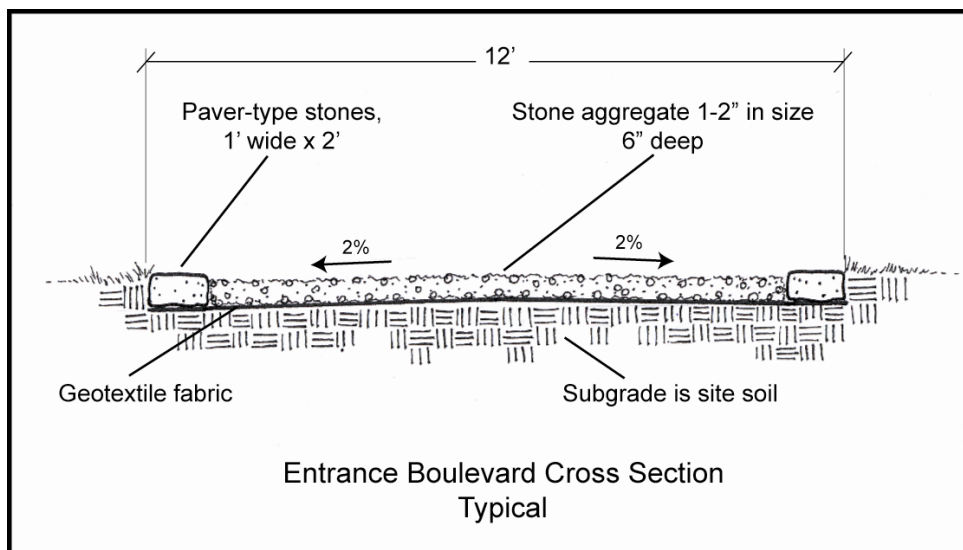
- 1) The Entrance Boulevard is the widest trail in the garden. It connects the garden entrance with the central node just past the orchard. The effect is one of a formal entry that invites the visitor to walk deeper into the garden.
- 2) Level One trails are wide enough for vehicular traffic. Their primary use will be as pedestrian trails for visitors. However, they will also be the main access roads for garden service vehicles. They may also be used by visitor vehicles for special events.
- 3) Level Two trails are the main pedestrian routes through the garden. They form the organizational structure of the garden by providing interconnected access to all of the garden's areas and collections.
- 4) Level Three trails are pedestrian trails through individual displays. They differ from level two trails principally in that they may not lead to a destination, but will provide access to the interior of a display.

### Trail Treatments and Material Guidelines

The surface material chosen for a trail level will be used on all trails of that level throughout the garden, with the exception of level three trails and some level two trails, as explained below. Consistent use of surface materials in this way helps visitors "read" the circulation system, which enhances navigation.

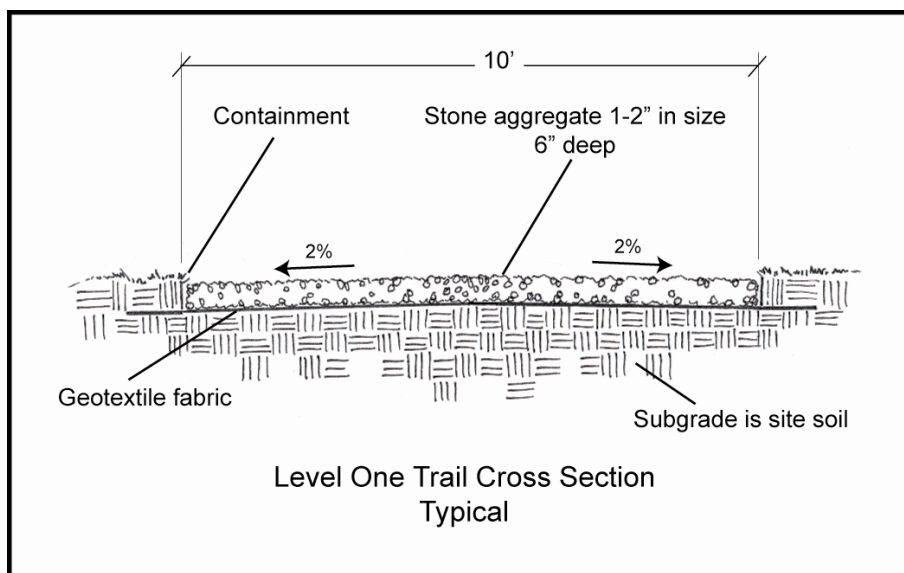
Proper trail preparation and construction, such as soil compaction and the use of liners, will increase trail longevity and reduce short-term maintenance.

**Entrance Boulevard:** Surface of stone aggregate, crushed gravel, or similar material, compacted after application, over a geotextile liner, to provide a durable surface which is easily distinguishable and low-maintenance. The geotextile fabric helps support the stone aggregate and keep it from migrating into the ground (Flink and Searns 1993). Paving stones lining the edges add to the formal appearance of this trail. [See Figure A-4.](#)



**Figure A-4: Entrance Boulevard Cross Section**

**Level One Trails:** Surface of stone aggregate, crushed gravel, or similar material compacted after application. The subgrade should be compacted as much as possible. The geotextile fabric helps support the stone aggregate and keep it from migrating into the ground (Flink and Searns 1993). Eliminating the ruts will create a more comfortable and safer experience for the visitor as well as eliminating unwanted drainage ditches. [See Figure A-5.](#)



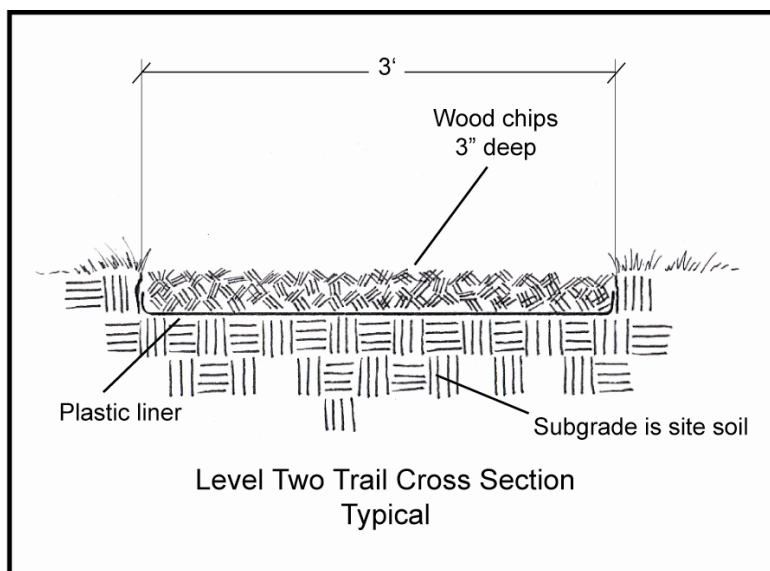
**Figure A-5: Level One Trail Cross Section**

**Level Two Trails:** With the exceptions noted below, surface should be wood mulch throughout the garden. The trail base should be prepared with a liner of plastic or

weed fabric to keep out weeds and reduce short-term maintenance. [See Figure A-6.](#) Wood mulch will likely need replacement once a year on a rotating schedule so that the mulch on all trails will not need to be replaced in the same month. When mulch is replaced, the under-liner should be inspected and replaced as needed.

Some level two trails in the outer garden are too steep for bark mulch. These trails may be left unmulched, as deemed appropriate by garden staff, because the natural soil surface of these trails enhances the untamed character of the outer garden.

The only modification to this scheme will occur where the Plants of the Maya trail intersects with other trails, as explained under *Intersections* below.



**Figure A-6: Level Two Trail Cross Section**

**Level Three Trails:** These trails will vary in size and surface treatment according to the nature of the display, using whatever materials are most appropriate. Because of this, there is no “typical” trail to illustrate. The base for these trails will still be prepared with a plastic liner or geotextile fabric to reduce short-term maintenance.

### Intersections

Trails will intersect at angles as close to 90 degree as possible. The only exception should be where level two trails intersect level one trails closed to public access. These intersections may be aligned so that they are visible from only one direction, making the public trail more apparent. As an example, see [Figure A-12.](#)

Seating in some form will be provided at every intersection, except where a level two trail intersects a level one trail closed to public access. Some protection from the sun, whether in the form of a structure or plant material, will be provided at every intersection with seating. [See Figure A-16.](#)

Where two trails intersect, the surface treatment of the higher-level trail will continue unbroken through the intersection. The exception to this rule occurs where the Plants of the Maya trail intersects another. The Maya trail will continue unbroken through

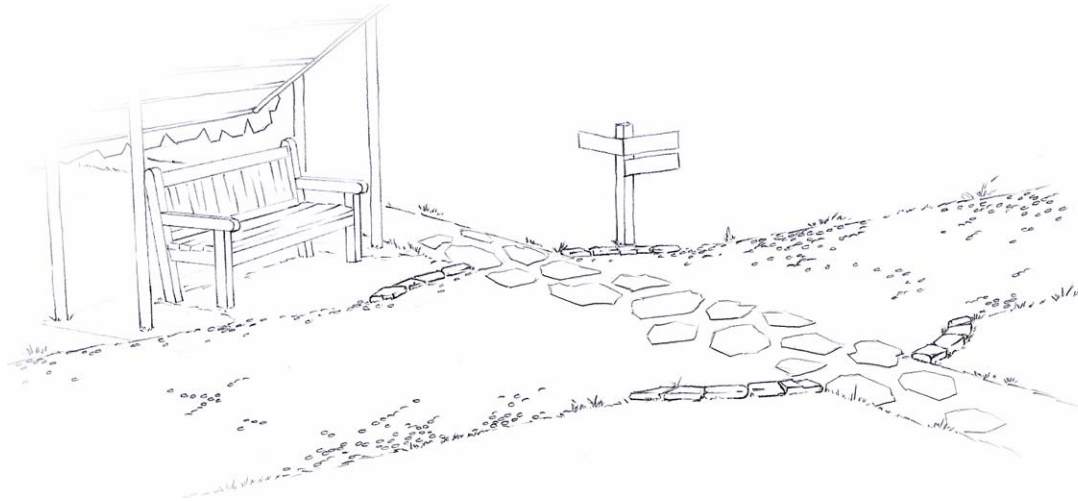


those intersections as a stone or other surface pattern that extends six feet on either side of the other trail. See [Figure A-8](#) and [Figure A-11](#).

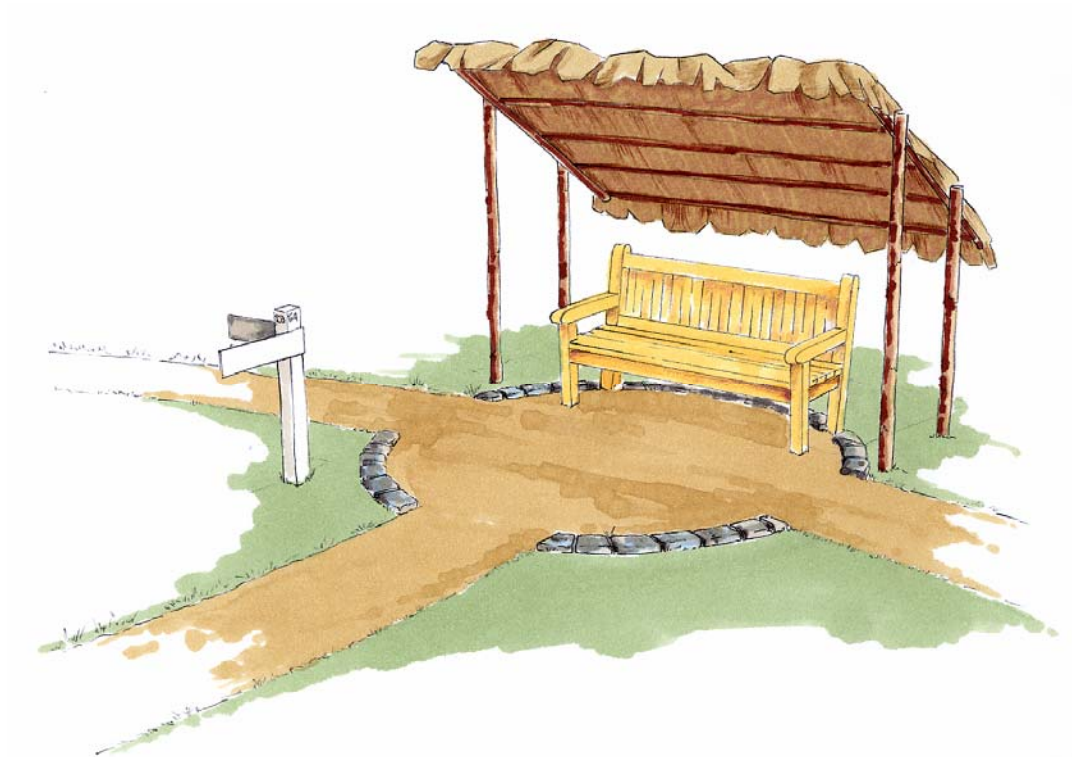
Typical intersections are illustrated in [Figures A-7 through A-15](#).



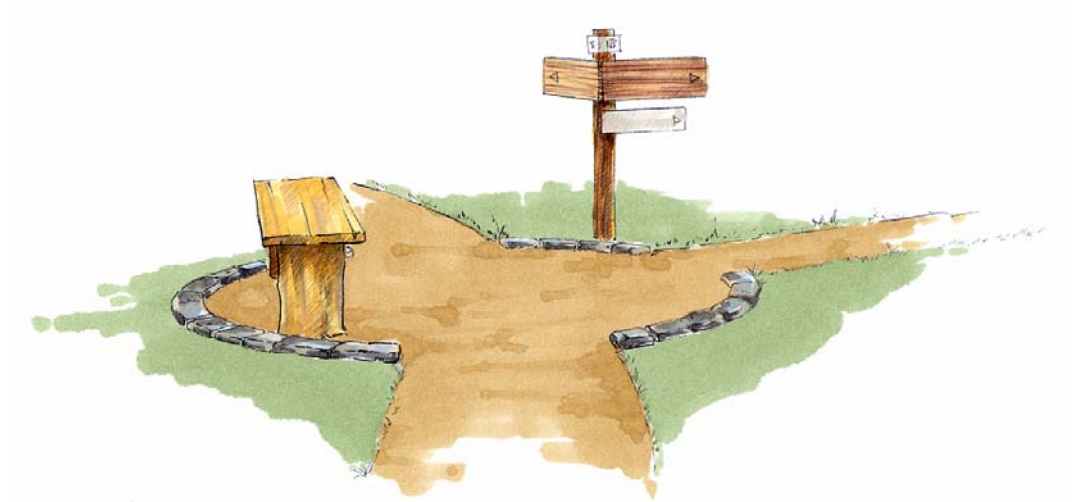
**Figure A-7: Typical Intersection of Level One and Level Two Trails, with Shade Structure**



**Figure A-8: Typical Intersection of Level One Trail and Maya Trail. Note that stones only continue for a few feet on either side of the intersection.**



**Figure A-9: Typical Intersection of Level Two Trails in the Inner Garden with Shade Structure**

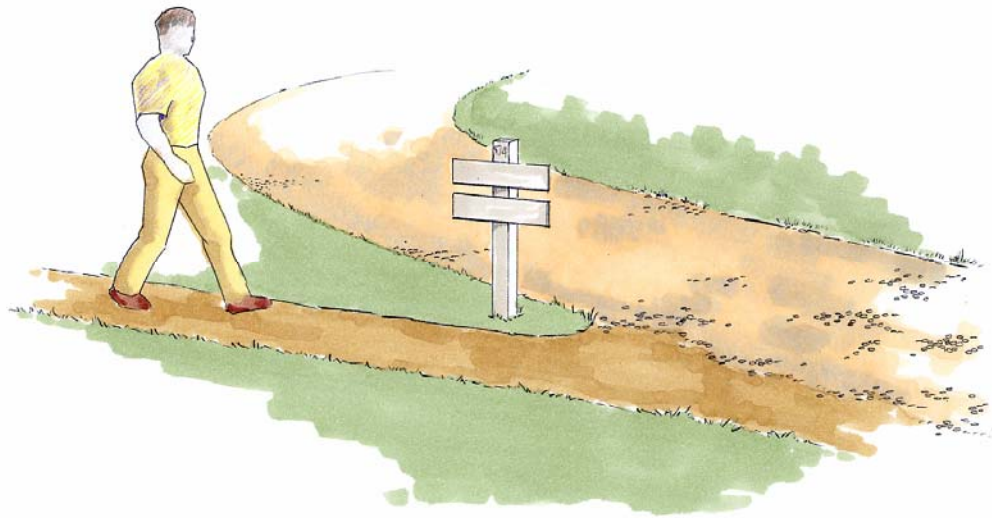


**Figure A-10: Typical Intersection of Level Two Trails in the Outer Garden**





**Figure A-11: Typical Intersection of Level Two Trail and Maya Trail. Note that stones only continue for a few feet on either side of the intersection.**



**Figure A-12: Typical Intersection of Level Two Trail and Road Closed to Public Access**

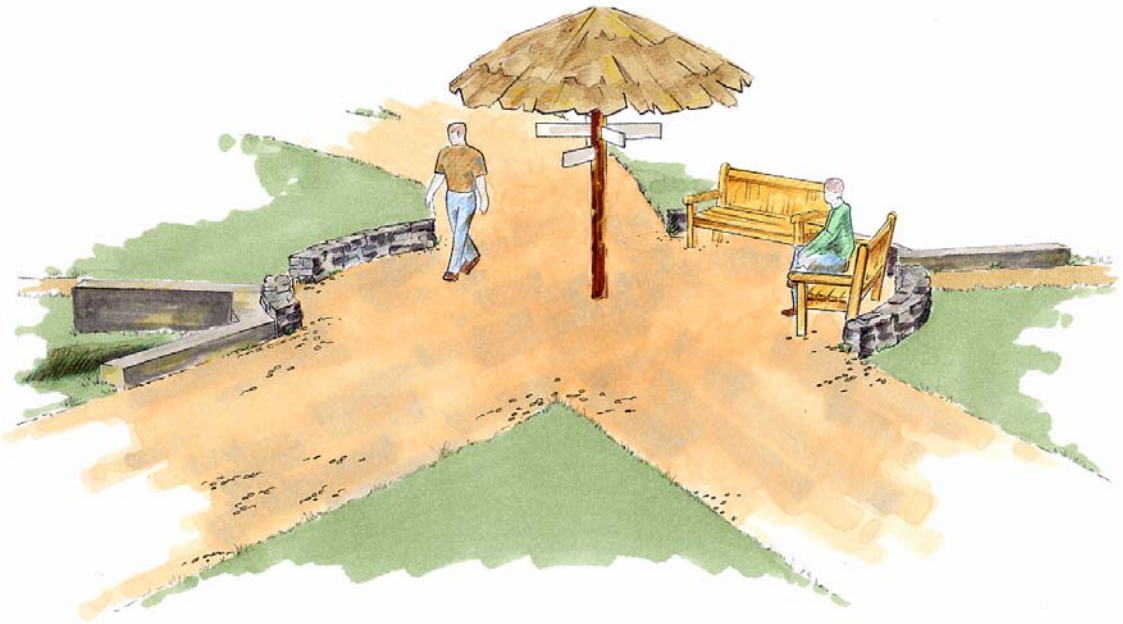


**Figure A-13: Main Entrance with Interpretive Signage**



**Figure A-14: Main Entrance with Optional Walls and Planters**





**Figure A-15: Central Node with Sign Post**



**Figure A-16: Suggested Shade Structure**

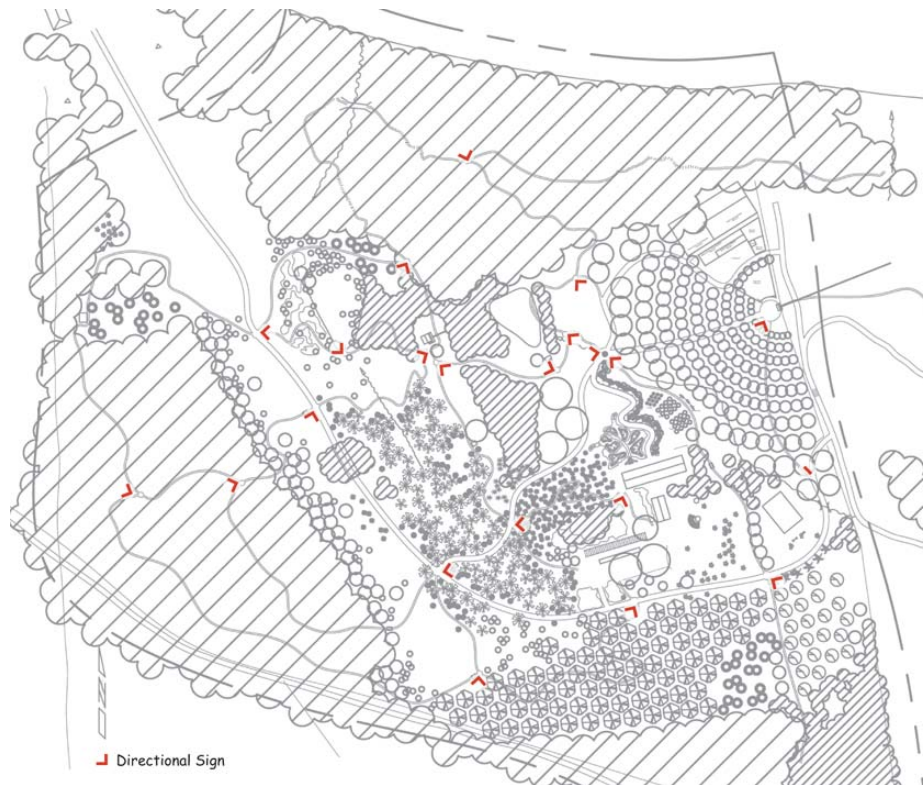
## SIGNAGE

As the most obvious navigational system, a well-designed network of signs can do a great deal to aid visitor navigation and comprehension of the garden. Signs can incorporate visual cues beyond words to create a cohesive experience for the first-time and the repeat visitor. All signs in the garden will be consistent, simple, and clear.

### Directional Signs

Directional signs are those that point the visitor to anything within the garden, whether feature or trail. Directional signs should be posted only at intersections. Directional signs are divided into four categories: Outer Garden signs, Inner Garden signs, Plants of the Maya Trail signs, and Self-Guided Tour signs. The differences in materials will stimulate conceptual differences among the areas.

Recommended locations for directional signs are marked on the map in [Figure A-17](#). At any given intersection, all directional signs will be fixed to a single post, when possible, in the configuration shown in [Figure A-18](#).



**Figure A-17: Directional Signage Suggested Locations and Orientation**



**Figure A-18: Posting Configuration of Directional Signs—Inner and Outer Gardens (not to scale)**

**Outer Garden** signs will be on a base of weathered wood with letters routed in and painted black or burned in deeply. Sign should be sealed with some type of protective coating to resist further weathering. Lettering style and size will match those used on inner garden signs. Each sign will be double-sided with both sides pointing to the same destination. See [Figure A-19](#).



**Figure A-19: Outer Garden Directional Signs**

**Inner Garden** signs will be on a wooden base painted white, with letters painted black as is currently done on directional and exhibit signs. If signs will last longer, the letters could be routed in before being painted black. Lettering style and size will match



those used on Outer Garden signs. Each sign will be double-sided with both sides pointing to the same destination. [See Figure A-20.](#)



**Figure A-20: Inner Garden Directional Signs**

**Plants of the Maya Trail** signs should have a graphic or color, or both, that identifies them as such. The graphic and color will be the same on signs in both the Inner and the Outer gardens. This will help people follow this trail with minimal reading. Signs will be on a wooden base painted the appropriate color, with letters painted black as per the Inner Garden signs. Lettering style and size will match those used on signs in the Inner and Outer Gardens. Each sign will be double-sided with both sides pointing to the same destination. [See Figure A-21.](#)

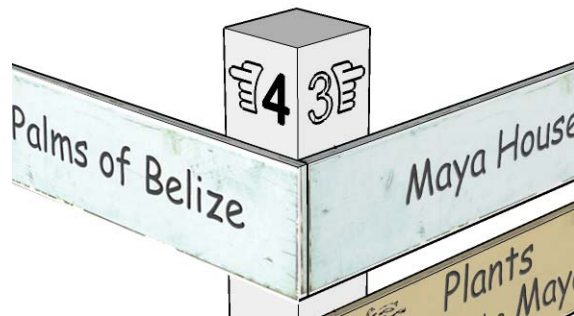


**Figure A-21: Plants of the Maya Directional Signs**

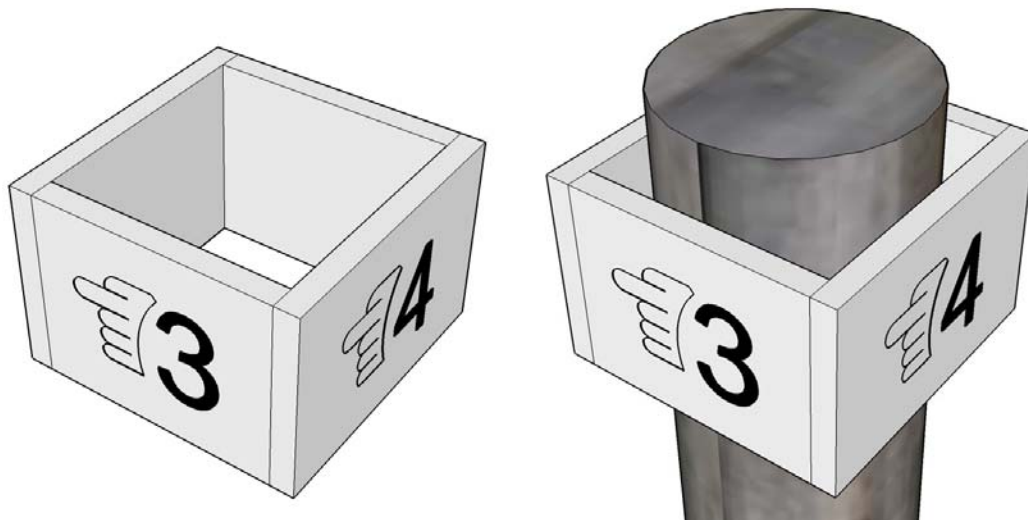
**Self-Guided Tour** signs will consist of a number in conjunction with some type of directional indicator. The suggestions illustrated in [Figure A-22](#) are based on Mayan glyphs. In the Inner Garden, this sign will be routed into the posts holding other directional signs, as shown in [Figure A-23](#). In the Outer Garden, this sign will be placed on a white box mounted to the top of the post holding other directional signs, as shown in [Figure A-18](#) and [Figure A-24](#).



**Figure A-22: Suggested Self-Guided Tour Pointer Options Based on Maya Glyphs**



**Figure A-23: Posting of Self-Guided Tour Signs in Inner Garden**



**Figure A-24: Self-Guided Tour signs for Outer Garden—Separate and On Post**

### Locational Signs

Locational signs are those that mark an exhibit or an attraction, such as the Orchid House. Locational signs will be the same as are currently used: a wooden base painted white with lettering in black. Lettering style should match that used for directional signs; lettering size should be larger. [See Figure A-25.](#)



**Figure A-25: Sample Locational Signs**

### Interpretive Signs

Interpretive signs are any intended to explain or educate. These signs should be conveniently placed at every exhibit, as well as along the trail where a teaching opportunity might present itself. Major trail intersections would be one suitable location. Much of the educational information presented on the garden's website should be incorporated into the garden. This information deepens the BBG experience and improves understanding of the garden's work.

Interpretive signs will be on green tin with hand-painted lettering. Lettering color and size can vary as appropriate for the application and amount of information presented. [See Figure A-26.](#) The sign panel will be mounted within a frame of suitably sized (2–3" diameter) palmetto logs and posted no more than 18" off the ground. This height (1) will make the sign more accessible to children and (2) may reduce the visual impact of these signs. [See Figure A-27.](#)



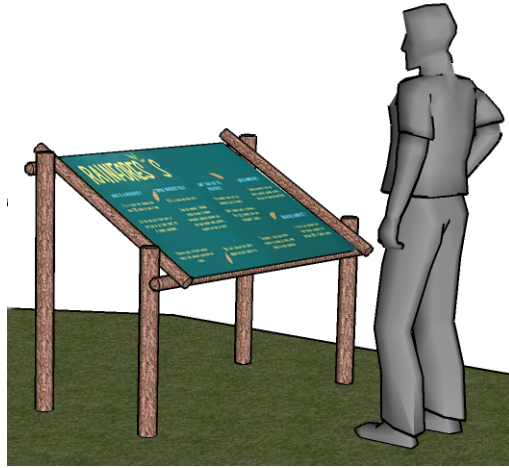


Figure A-26: Sample Interpretive Sign (existing in garden)



Figure A-27: Upright Interpretive Sign

As an alternative where a sign may block views from a given point, interpretive signs may be posted on angled displays, as shown in [Figure A-28](#). Construction materials will be as just described.



**Figure A-28: Angled Interpretive Sign**

Sign orientation may vary between portrait and landscape to blend with its location. Sign size may also vary based on content. Interpretive signs should be placed so that, when possible, they are not visible from other areas of the garden.

#### Sponsorship Signs

As BBG acquires more sponsorships and donations, a need will develop to appropriately and consistently identify contributing organizations and individuals. Now is the time to establish standards for sponsorship signs.

The following recommended standards should be followed unless a sponsor is unwilling to conform due to stringent corporate guidelines. The guiding principles for signs in this category are that they should not detract from the exhibit or the surroundings, such as with bright colors or backgrounds, and they should adequately identify the sponsor. As a rule, sponsorship signs should use organic colors and materials that blend with the site.

The International Palm Society logo at the Palms of Belize Display provides a good pattern for future sponsorship signs. [See Figure A-29.](#)



**Figure A-29: Sample Sponsorship Sign—Neutral/Natural Colors, Simple Patterns**

### Plant Identification Tags

The current plant identification system should be continued. Tags for plants that pertain to the Plants of the Maya trail should match the color/graphic combination of the Plants of the Maya directional signs.

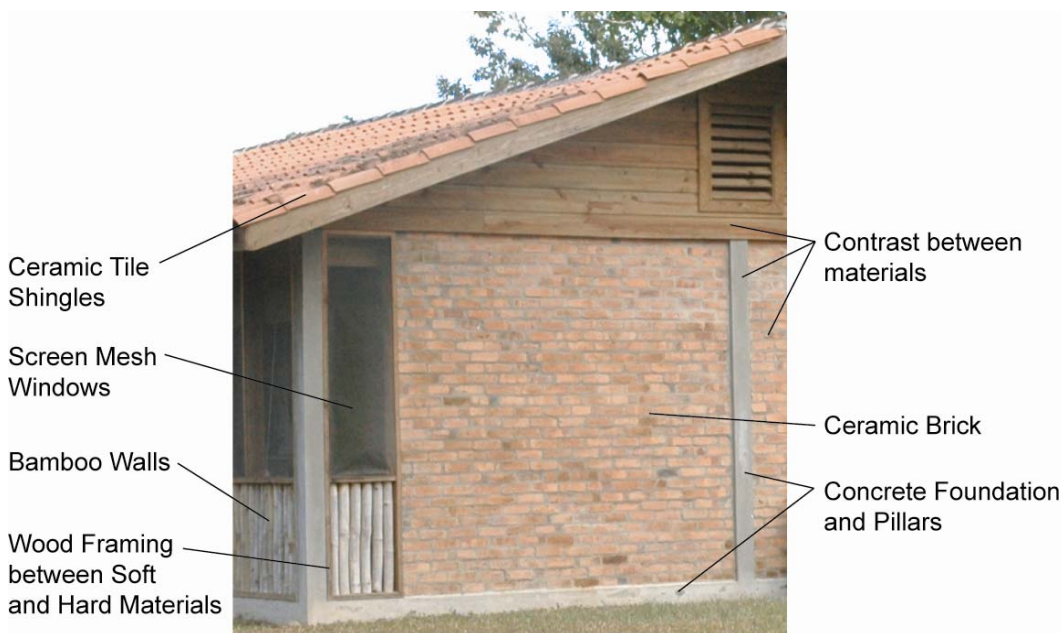
## **STRUCTURES**

Structures of many kinds and types are often part of a botanic garden and may range from bridges and walls to hot houses and visitor centers. Although uniformity in built elements is not as critical to a cohesive visitor experience as is uniformity in signage, the use of similar architectural styles and materials can create a theme throughout a garden and a unique visitor experience. Sometimes it's the details that instill a sense of quality and caring.

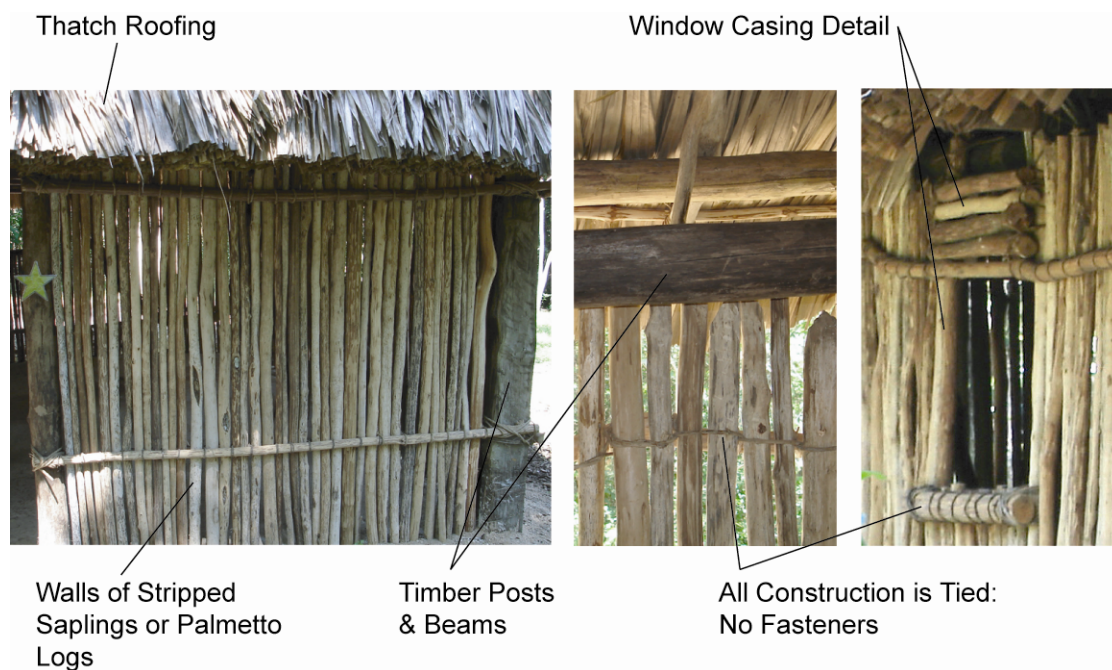
All structures in BBG should use native and/or locally available materials, as is currently done. This will preserve the natural feel of the garden and contribute to the local economy. Examples of currently-used materials include bamboo, palmetto logs, river stone, thatching for roofs, ceramic brick, ceramic roof tiles, and concrete.

### Buildings

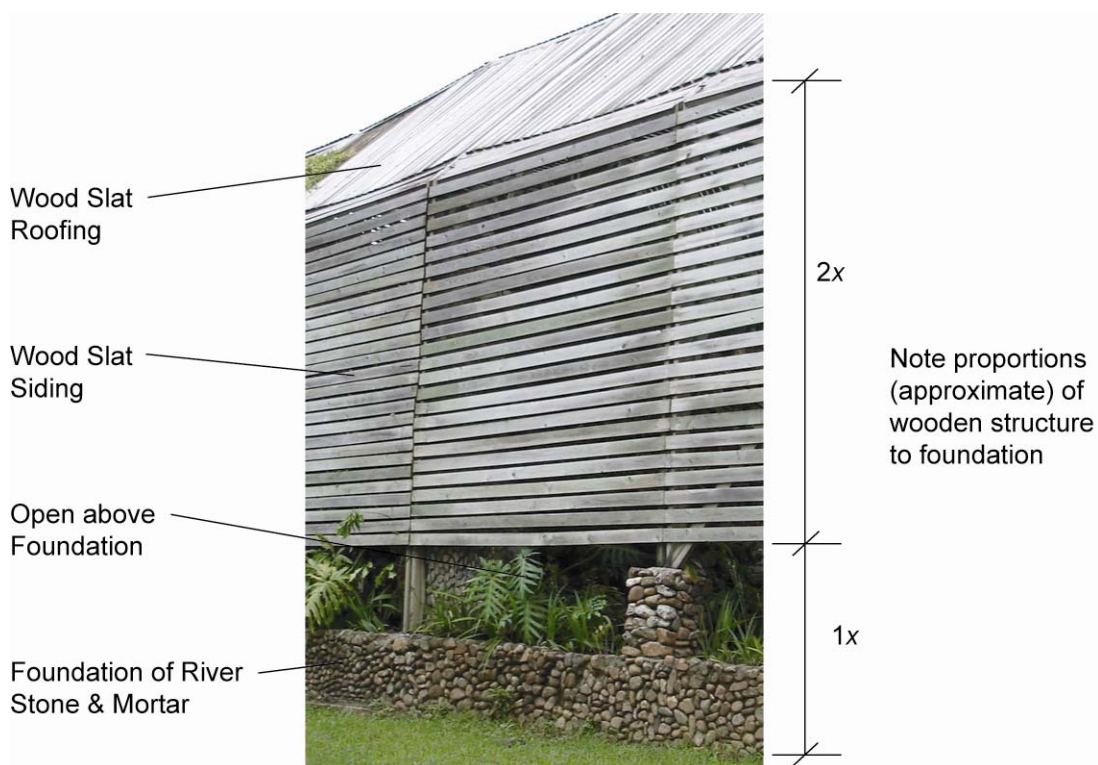
Because the numbers and types of future buildings at BBG are unknown, it is impossible to provide detailed design guidelines. In addition, due to their purposes or locations in the garden, not all buildings should conform to every particular of the following standards. However, where and when appropriate, the design of new buildings should adhere to the following principles. See [Figures A-30 through A-32](#).



**Figure A-30: Guidelines for Fully-Enclosed Buildings, Based on Conference Center (for Tool Shed, Future Offices, or Visitor Center)**



**Figure A-31: Guidelines for Open Buildings, Based on Maya House (for Shade Structures and Interpretive Displays)**

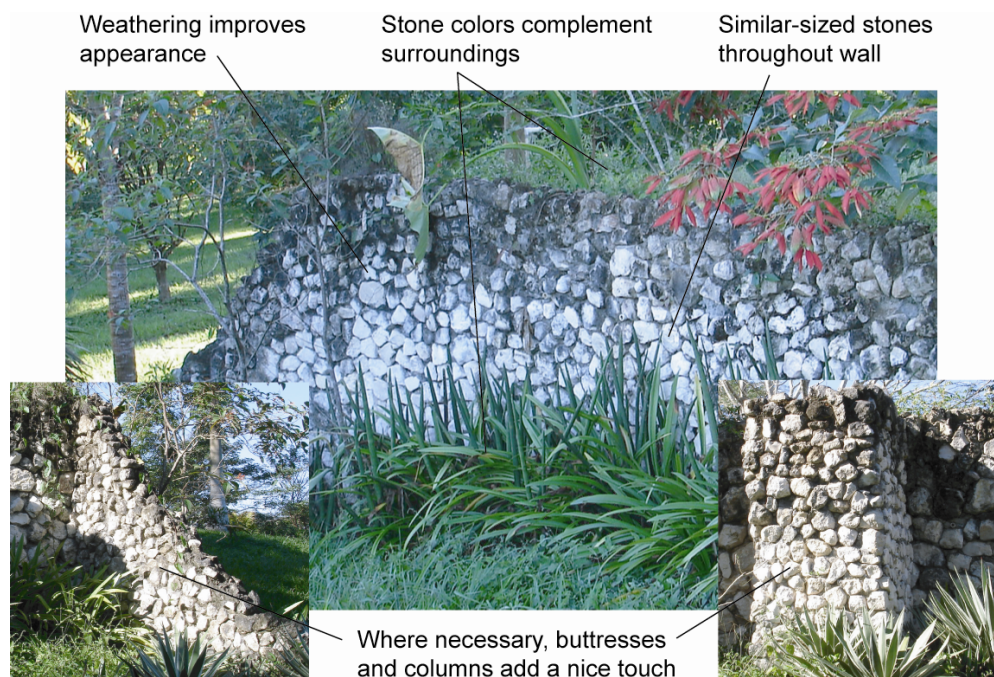


**Figure A-32: Guidelines for Special Plant Collections and Special Purpose Buildings**

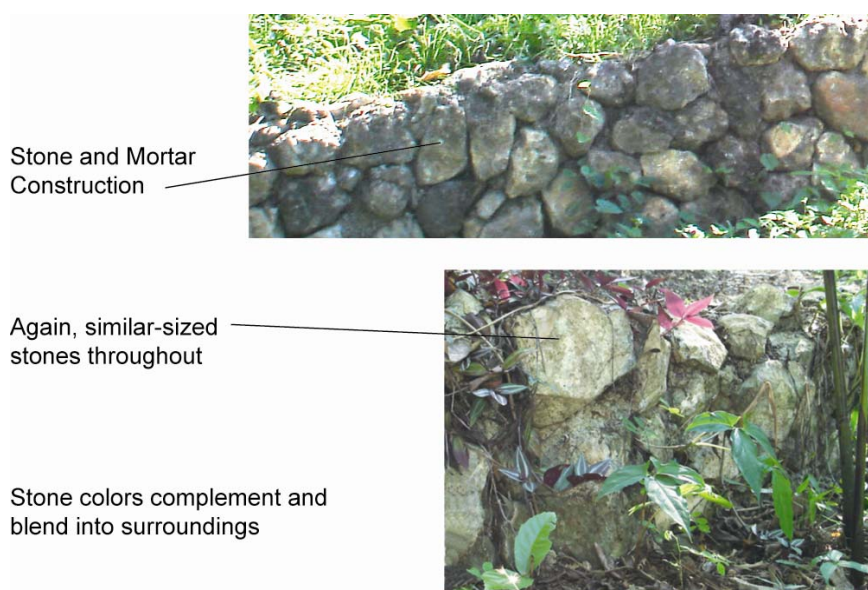


## Walls

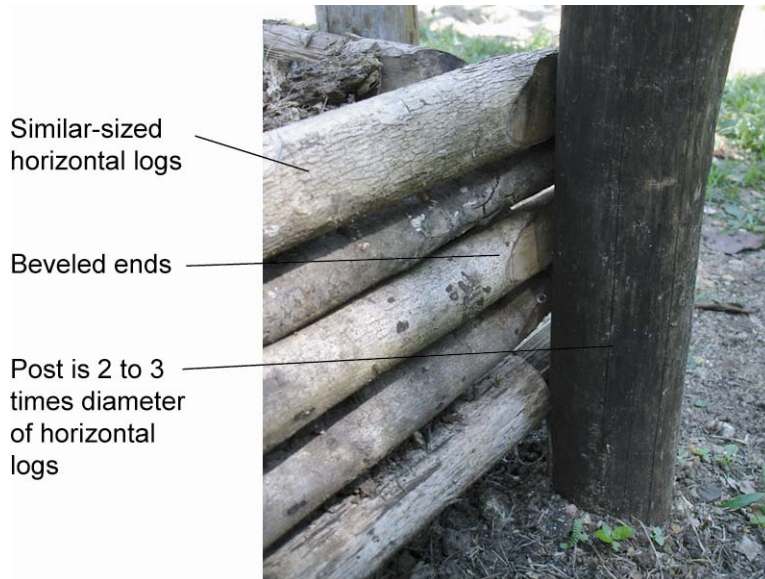
Walls can serve a variety of purposes in any landscape. They can direct traffic, retain earth at grade changes, separate uses, and guide the eye. Use of the same materials for walls with similar purposes shows care in planning and detailing. See [Figures A-33 through A-35](#).



**Figure A-33: Guidelines for Stone Retaining and Other Walls, Option 1**



**Figure A-34: Guidelines for Stone Retaining and Other Walls, Option 2**



**Figure A-35: Guidelines for Wooden Retaining Walls (limited application)**

## PLANTINGS

Space is the major medium of design (Johnson and Becker 1976), and as with any outdoor place, people perceive and use BBG as spaces. The garden's collections and plantings form these spaces. Therefore, careful consideration must be given to how plants are used and how collections are organized.

Plants have many purposes in a landscape, including aesthetic, functional, and ecological. This master plan will focus on the aesthetic and functional as they pertain to defining space. Good use of plants can create visual order and continuity, reinforce navigation systems, and provide a proper setting for the display of horticultural collections (Johnson and Becker 1976). Therefore, the planting design guidelines that follow are intended to:

1. Create continuity throughout the garden
2. Create balance throughout the garden
3. Use plants to reinforce spatial hierarchy

### Continuity

Continuity refers to the visitor's perception that the garden is a single entity or experience, not a series of unconnected spaces. Plants can provide this continuity when specific species, sizes, forms, colors, or textures are consistently used for particular visual purposes. Groups of plants sharing similar characteristics can provide this continuity by serving as the structural elements that define spaces in the garden.

A clear example of **Continuity through Use** would be to place trees of different sizes to designate the importance of paths in a circulation system (Johnson and Becker 1976), or to always use a particular plant grouping to designate entrances. One way to implement this principle in BBG would be to plant *Schippia concolor*, the native palm



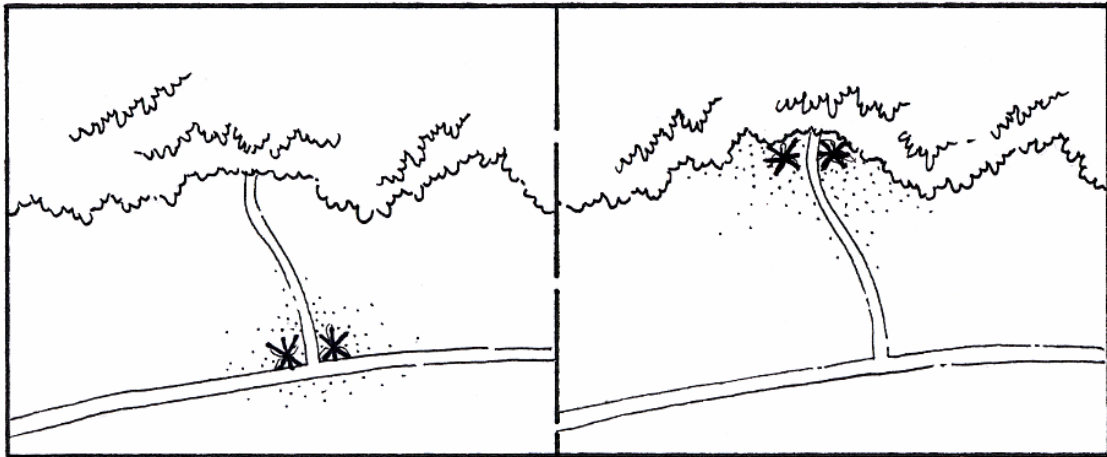
proposed for the garden entrance, at all major intersections, possibly in a similar grouping.

Guidelines for fostering continuity through use:

1. Select a number of plant species, preferably native to the area, that will best lend themselves to repetition throughout the garden. These should be plants that are not highlighted as primary elements of any collection. Use these plants in attractive arrangements to separate collections and fill unprogrammed areas. By using the same set of plants strategically throughout the garden, visitors will begin to recognize them and, hopefully, better distinguish the collections. These plantings will likely be attached to structural plantings, which are explained later.
2. At transitions between collections or garden areas, use symmetrical groupings of plants that contrast in form, texture, or color with the plants in the collection. The contrasting plants should be in scale with plants in the collection. [See Figure A-36](#). Doing this consistently will help visitors recognize transitions. Do not overuse this technique. Some transition areas will be more effective without a “gateway”. Also, the gateway plants should be close enough to the collection that they appear related. [See Figure A-37](#).



**Figure A-36: Symmetrical Plantings at a Transition Point or Gateway**



**Figure A-37: Improper (left) and Proper (right) Placement of Gateway Plantings**

**Continuity through Structure** is partially illustrated in the mass/space diagram in [Figure A-38](#), which highlights the current structural plantings in BBG. These thick stands of trees and underbrush effectively separate areas of the garden. They differ from other planted areas in that the visitor cannot pass under the canopy, physically or visually, as they can in other areas. These stands provide continuity by serving as relatively uniform edges to collections and open spaces and by providing uniform backdrops to collections.

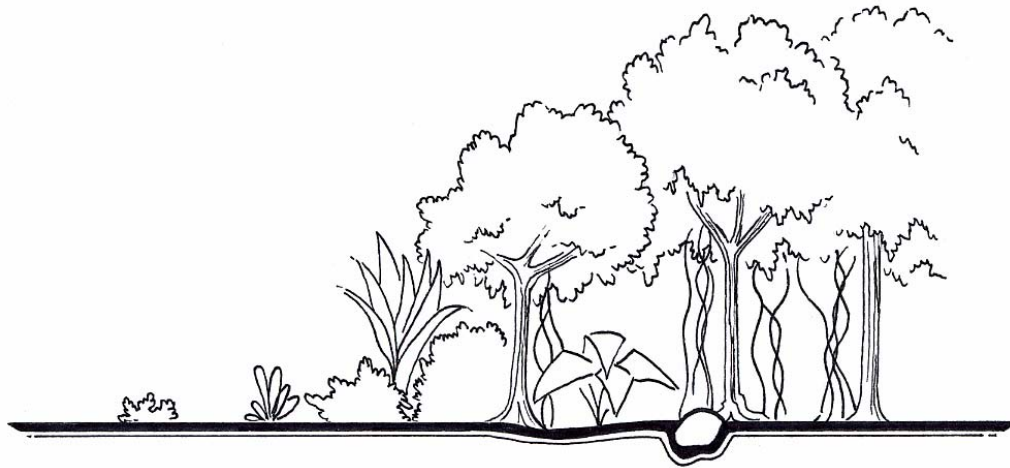
Guidelines for preserving structural continuity include:

1. Preserve thick plantings with dense undergrowth between collections and garden “rooms.”
2. Expand or reduce these structural stands as necessary to define new and existing spaces and rooms.
3. As much as possible, plant structural stands in native trees and underbrush that would naturally occur together in communities and that will grow with little maintenance and irrigation.
4. If used as a backdrop, clearly define the edges of these stands and use patterns, textures, and colors that do not detract from the collection in front.
5. When structural plantings front open space, principles of edge and mingled drift (Morrison 2004) should be employed at the transition. These principles are illustrated in [Figures A-39 and A-40](#).

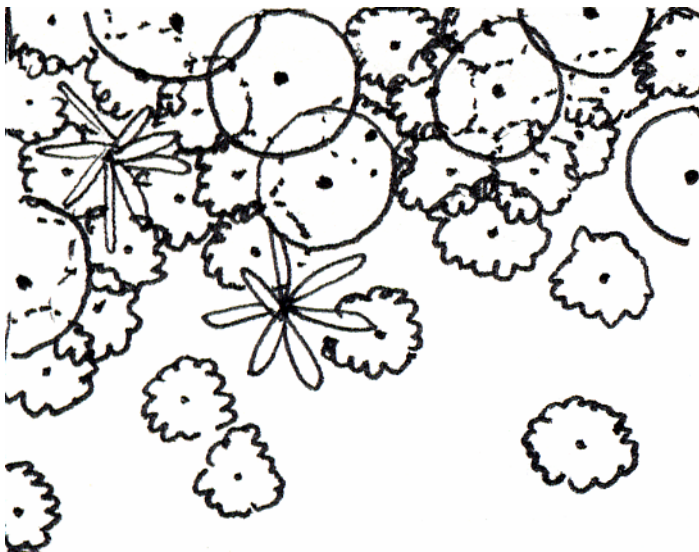




**Figure A-38: Mass/Space Diagram of BBG**



**Figure A-39: Edges Should Taper from Ground Level to Canopy**



**Figure A-40: Plan View of Mingled Drift—No Hard Edge**

### Balance

Balance is a state of equilibrium achieved through the juxtaposition of elements that offset one another. It can be a compositional and an experiential phenomenon. BBG achieves compositional balance through symmetry at entrances ([Figure A-41](#)) and the juxtaposition of formal and naturalistic plantings in other areas ([Figure A-42](#)). BBG achieves experiential balance in the contrast between open areas and thickly-planted, canopy-covered areas.



**Figure A-41: Example of Balance through Symmetry**



**Figure A-42: Example of Balance through Contrast—Formal Plantings (left) and Naturalistic Plantings (right)**



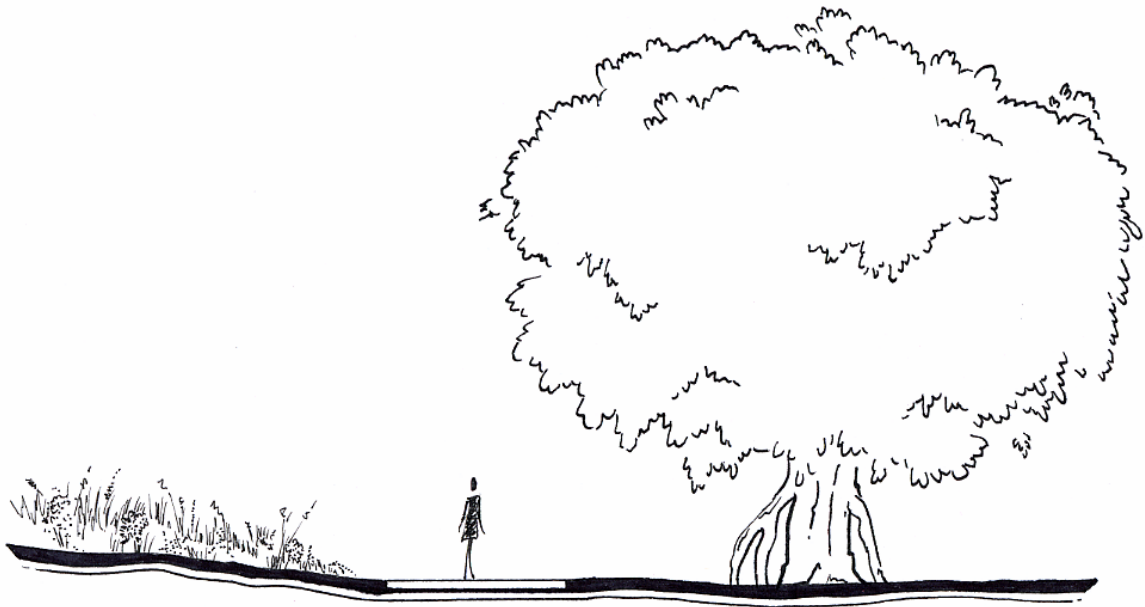
Compositional balance can also be achieved by paying careful attention to the surroundings of a plant or planting. This contextual balance can be found in relationships (family, species), complements (colors, textures, forms), and contrasts (colors, textures, forms) with elements adjacent to a planting. See [Figure A-43](#) for an example of this.



**Figure A-43: Example of Contrasting Textures and Forms that Balance Each Other**

Guidelines for enhancing balance throughout BBG.

1. Accentuate the contrast between open and vegetated areas by carefully maintaining marked open spaces. Such open spaces should be in scale with adjoining planted areas. In other words, the open space should be large enough to provide visual and emotional rest.
2. Look for opportunities to contrast size, form, shape, and texture across opposite sides of areas experienced as a whole. For example, the trail between the figs display and the native butterfly garden will provide an opportunity for balance. When mature, the massive fig trees will counterbalance the complexity, low stature, and finer textures of the butterfly garden. See [Figure A-44](#). This type of balance can be applied at any point in the garden.
3. Employ symmetry where an accent or a clear transition is desired; for example at the entrance to a collection. See [Figure A-41](#) above.



**Figure A-44: Example of Counter-Balanced Plantings**

### Spatial Hierarchy

Spatial hierarchy is the relative importance spaces have to one another. Typically, in a designed place, some spaces will seem more important than others. The idea is to make the distinction purposeful. Creating spaces of greater and lesser relative importance helps create variety, interest, and balance.

Guidelines for influencing spatial importance:

1. Identify areas of the garden that should be more important than others.
2. Where appropriate, use simple, strong, formal plantings to identify important spaces. “Formal” means simply that the planting can be clearly identified as man-made, often through the use of repetition and regularity.
  - a. For example, the entrance is a good area for a more formal treatment because it introduces Belize Botanic Gardens. The orchard trees lining the Entrance Boulevard should be evenly spaced and equidistant from the edge of the trail regardless of their size. This will create a formal experience for visitors.
  - b. The Central Node is a major decision point for the visitor. Its importance can be reinforced through a more formal treatment, such as plantings around the clearing that mimic the shrubbery starting on the southeast side of the node.
3. Where formal plantings are not appropriate, spatial importance can be signified through volume and scale (Johnson and Becker 1976). Larger, open spaces will generally feel more important than smaller, enclosed spaces. Smaller, enclosed spaces, however, will typically feel more intimate.

### Ecological Planting Design Principles: Habitats

The habitat displays at BBG are very important to the garden's educational mission. They highlight the core habitats of Belize in order to expose visitors to the country's biodiversity. However, due to space constraints and edaphic and climatic differences, it is not possible to fully duplicate these habitats within the bounds of BBG. Therefore, it is necessary to abstract them.

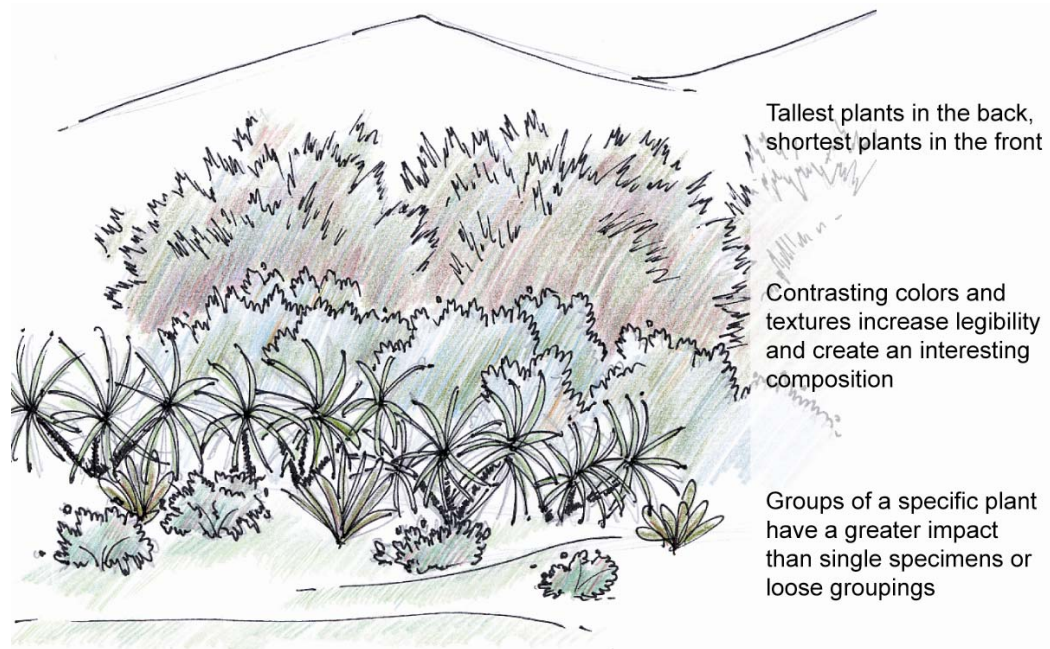
Based on observation, it appears that BBG staff is already familiar with some of the principles that follow. However, they are presented here in the hope that something new and useful will be found, and for the reference of future staff members. Most of these principles are taken from an article titled *A Methodology for Ecological Landscape and Planting Design – Site Planning and Spatial Design* (Morrison 2004).

1. Base the display on plant communities found in the reference habitat.
2. Plant each species in the appropriate environment with regards to soil, light, and moisture.
3. Use stylized or abstracted versions of the reference plant community that contain its most ecologically and aesthetically important species arranged according to the community's typical distribution patterns. In other words, determine what the layperson would associate with the selected habitat if seen in the 'wild' and replicate those features, accentuating aspects as necessary for visual clarity.
4. Modify distribution patterns if necessary to accommodate specific needs, such as views.
5. Blend the edges of habitat displays into surrounding plantings using principles of edge and mingled drift, as would occur in nature.

### Basic Planting Design Principles

Before leaving the topic of plant design guidelines, it is necessary to provide a brief overview of basic planting design principles in addition to those already mentioned. Many of these principles are taken from *Primer on Landscape Architectural Design with Plant Materials* (Johnson and Becker 1976) and *Basic Elements of Landscape Architectural Design* (Booth 1983).

1. Plantings that are meant to be appreciated as a group should be placed so that they can be seen from a distance. Typically this means that an open view must be kept clear.
2. When considered vertically, plant massings should be planned so that when viewed, the shortest specimens are in the front and the tallest in the back. Textures and colors should contrast to create visual effects and to make the species stand out as appropriate. See [Figure A-45](#).



**Figure A-45: Plant Massing Principles**

3. Groups of a specific plant have a greater impact than single specimens or loose groupings. See [Figure A-45](#).
4. Grasses and ground covers can be used to create implied spaces and to define the ground plane.
5. Small shrubs and plants can be used in groups or hedges to define space more strongly than grasses while preserving views and open space.
6. Large shrubs block views and therefore strongly define space, acting as solid walls. Planted opposite small shrubs and ground covers, large shrubs will direct views away from themselves and toward open space.
7. Small trees can define space like large shrubs, but they also allow views beneath their canopies, creating a spatial flow (Johnson and Becker 1976).
8. Large trees typically dominate any landscape due to their size. From a distance, they can form a backdrop for other spaces and plantings. From below, they create a ceiling and direct views horizontally, often punctuated by trunks. This canopy effect can be inspirational or confining depending on the height of the trees.
9. Dense vegetation that screens horizontal views can still contribute to vertical open space if the canopy is left open.
10. Through their placement, plants can be used to attract attention to a given area or to block views. Alternately hiding and revealing a point along the progression of a trail results in a sense of mystery (Morrison 2004) that can heighten the anticipation of arrival.

#### Plantings Conclusion

Ultimately, all the designed elements of Belize Botanic Gardens should enhance the visitor experience. Careful use of plants in collections and groupings can do this

without detracting from BBG's educational and research missions. In fact, good design will augment the garden's educational potential at the same time it makes the garden more accessible and enjoyable.



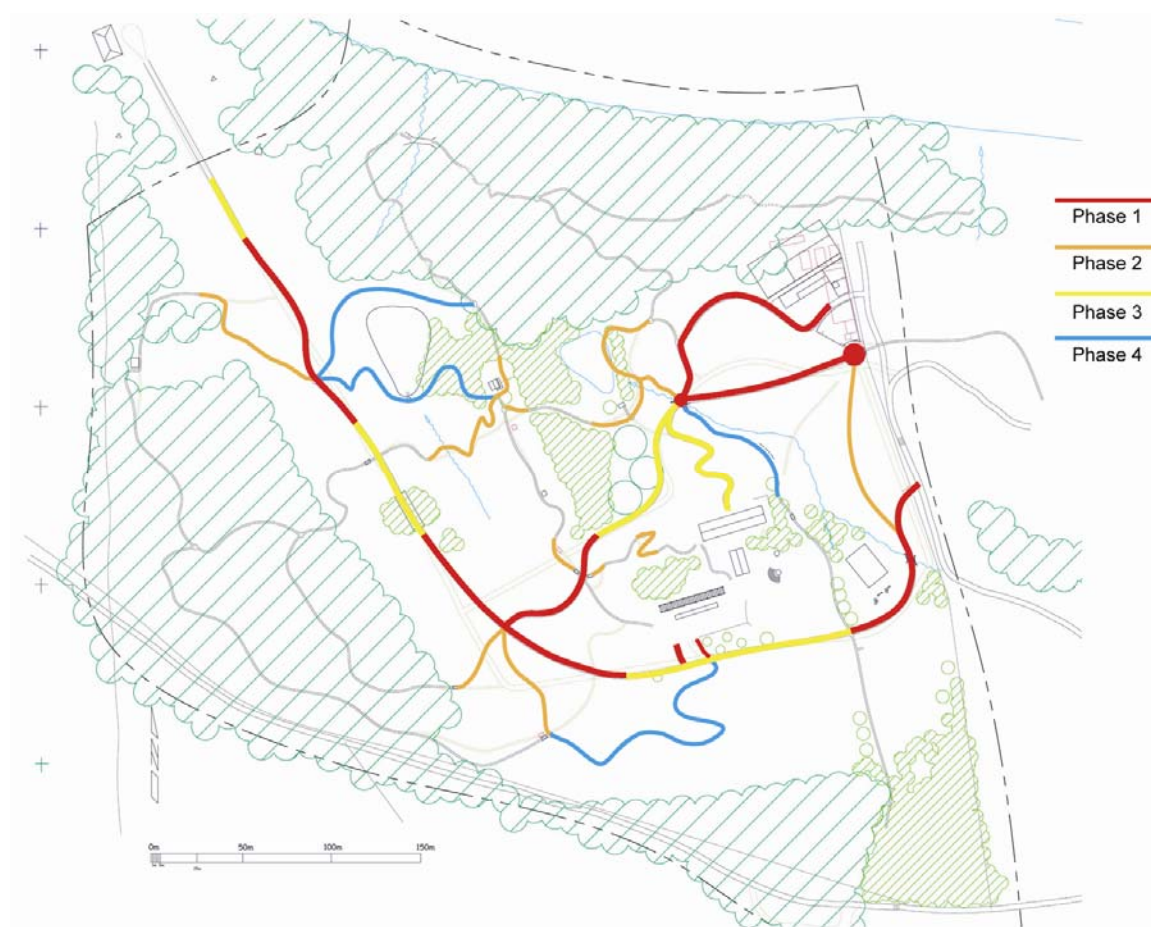
## Phasing

It will take time to fully implement the recommendations set forth in this master plan. In order to make the most efficient use of BBG's limited resources, the recommendations must be prioritized and an implementation schedule developed. The following suggested implementation schedule attempts to balance highly visible changes with practical needs in a logical progression that lays the foundation for future work.

## IMPLEMENTATION PHASES

The primary implementation phases address the proposed trail system. The changes associated with the trail improvements will have the greatest visible impact on the garden and the visitor experience. Completed, the trail system will form the organizational structure of the garden and its collections. Having it in place first will guide other changes and improvements and minimize repetitive work.

The phases are mapped in [Figure A-46](#). In cases when the topography of an area suggests a trail alignment different from that recommended in the plan, the topography should overrule while respecting the reasons behind the proposed realignment.



**Figure A-46: Trail Implementation Phases**

### Phase 1

This phase puts in place the key points of the proposed trail system. Most of the other trail changes will tie into these points. Phase 1 changes are marked in red in [Figure A-46](#). Phase 1 should be completed during years 1 and 2 of the Design Master Plan implementation. Proper trail construction and surfacing should be used during this phase.

As the new trails and alignments are put in place, obsolete trails should be removed and allowed to grow over. Existing vehicular roads will likely need some assistance in the form of filling ruts and removing rocks.

1. Move the service entrance from its current position next to the garden entrance to its proposed position further south down the road, and realign the Level 1 trail in the south-east corner as shown on the plan.
2. Align and install the entrance circle and the Entrance Boulevard using appropriate materials.
3. Construct the Central Node.
4. Align and install the Level 1 trail/service road that will connect the Central Node to the Nursery area.
5. Realign the Level 1 trails in the south-west corner, smoothing out the bend in the trail, as shown on the plan.
6. Realign the Level 1 trail leading to BBG Manager's home with "bump," as shown on map. This realignment is intended as a visual cue to visitors that they should proceed no further down this road.
7. Install vehicle-only and pedestrian connections between southern-most Level 1 trail and Vine Pergola area.

### Phase 2

This phase realigns and closes existing trails, primarily Level 2, in accordance with the proposed trails plan. These changes are marked with orange in [Figure A-46](#). Proper trail construction and surfacing should be used during this phase.

As the new trails and alignments are put in place, obsolete trails should be removed and allowed to grow over. Existing vehicle roads will likely need some assistance in the form of filling ruts and removing rocks.

1. Align and install the Level 2 trail originating at the entrance and running south and north through the orchard.
2. Construct the boardwalk that will extend into the pond.
3. Realign all other Level 2 trails as shown on the plan and remove the old trails.

### Phase 3

During this phase, existing trails that have not been properly surfaced will be. Those trails most likely to need resurfacing are marked yellow in [Figure A-46](#).

1. Prepare and resurface trails as per design guidelines.

### Phase 4

This phase adds new trails to the system. Those involved are marked with blue in [Figure A-46](#).

1. Align and install new trails using appropriate construction and surfacing.

## Conclusion

Belize Botanic Gardens is a beautiful place in a beautiful setting. Its programs are impressive and of great worth to Belize and its citizens. However, its current physical manifestation is sometimes confusing and unfinished, both of which detract from the visitor experience. It is hoped that the recommendations set forth in this design master plan will alleviate these issues and lay the foundation for years of successful, enjoyable, and expanding operations.



**Figure A-47: Belize Botanic Gardens Master Plan Illustrative**

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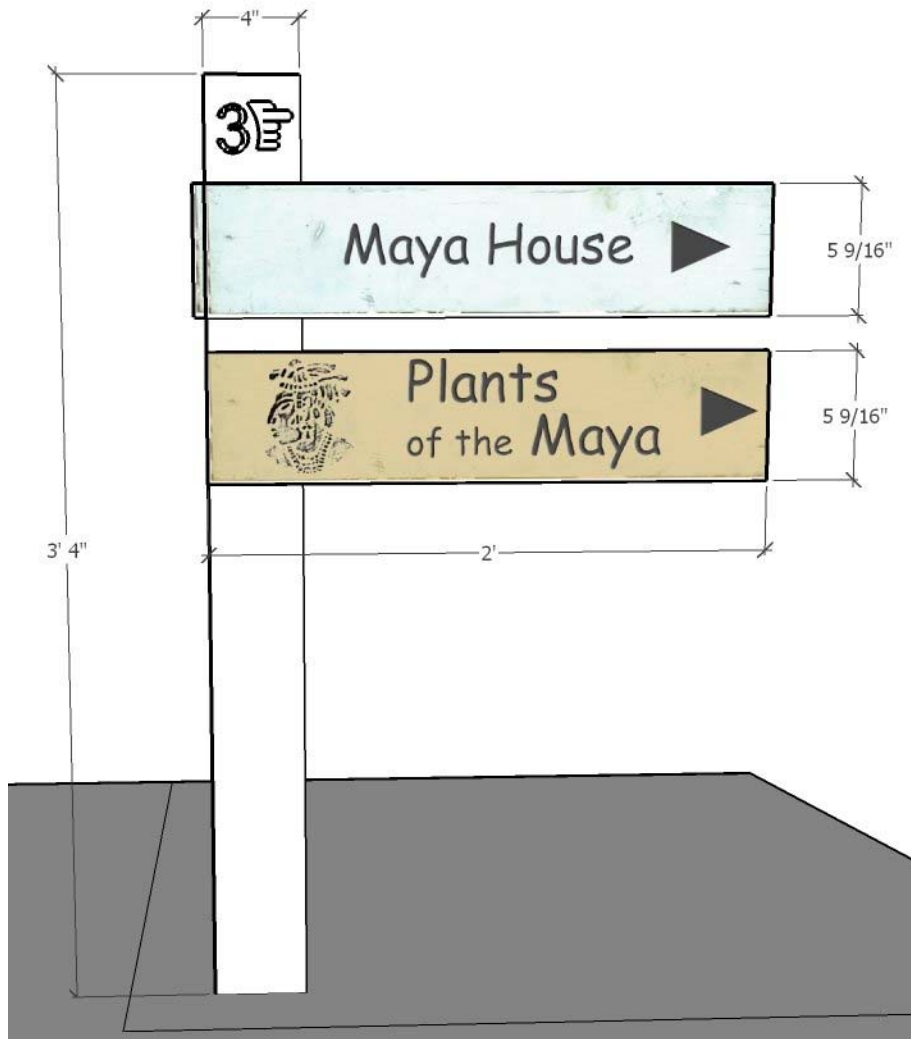
## Appendix: Dimensions

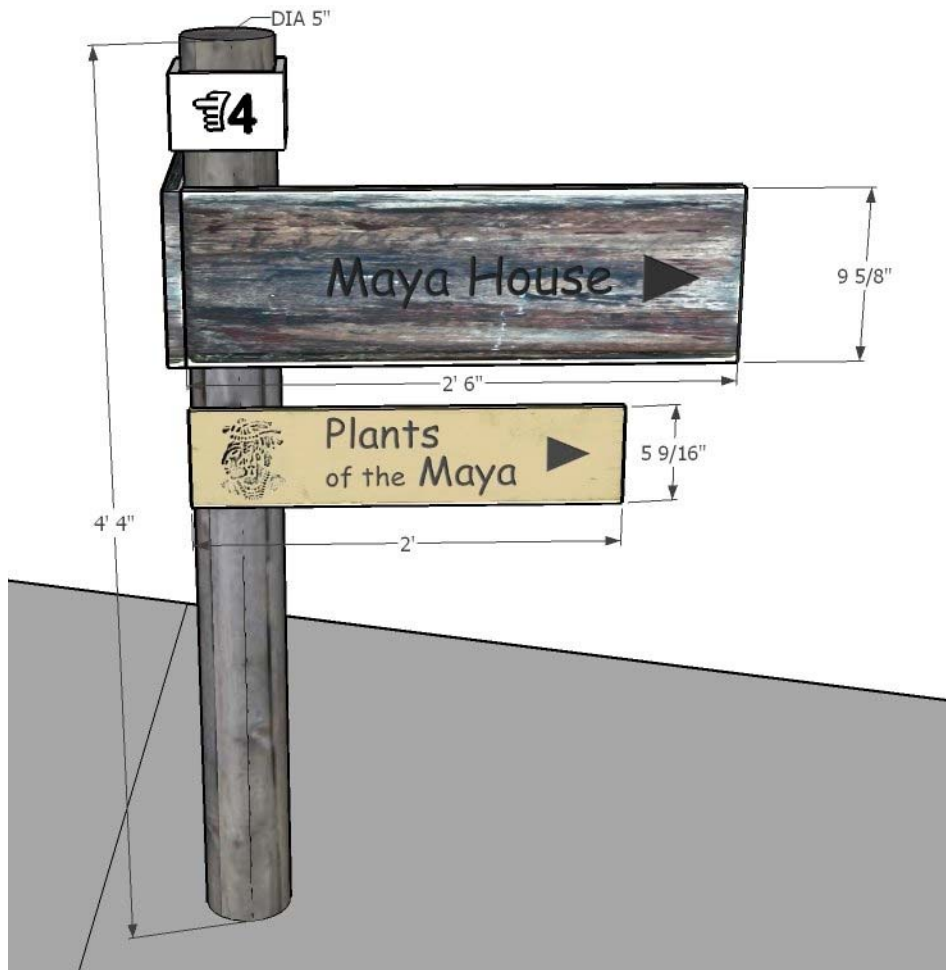
This appendix provides suggested measurements and dimensions not provided in the BBG Design Master Plan.

### TABLE OF CONTENTS

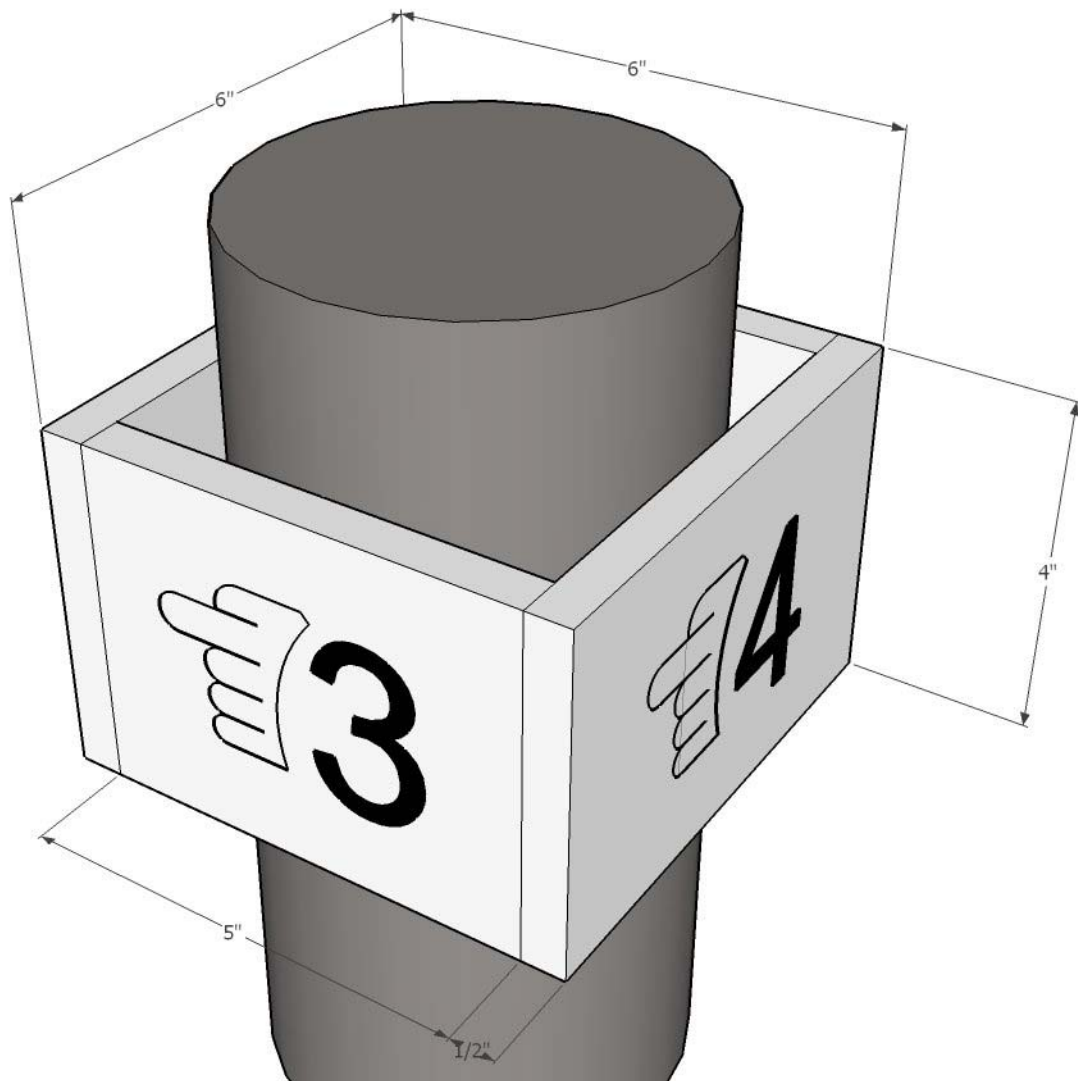
Signage Dimensions.....	175
Directional Sign Dimensions .....	175
Upright Interpretive Sign Dimensions .....	178
Angled Interpretive Sign Dimensions .....	179
Entrance Interpretive Sign Array Dimensions .....	181
Proposed Entrance Sign Dimensions .....	185
Structure Dimensions.....	186
Shade Structure Dimensions .....	186
Intersection Dimensions.....	189
Entrance Dimensions .....	192
Plan View.....	193
Vertical View Three Dimensional .....	197



**SIGNAGE DIMENSIONS**Directional Sign Dimensions**Figure A-48: Dimensions for Inner Garden Directional Signs**

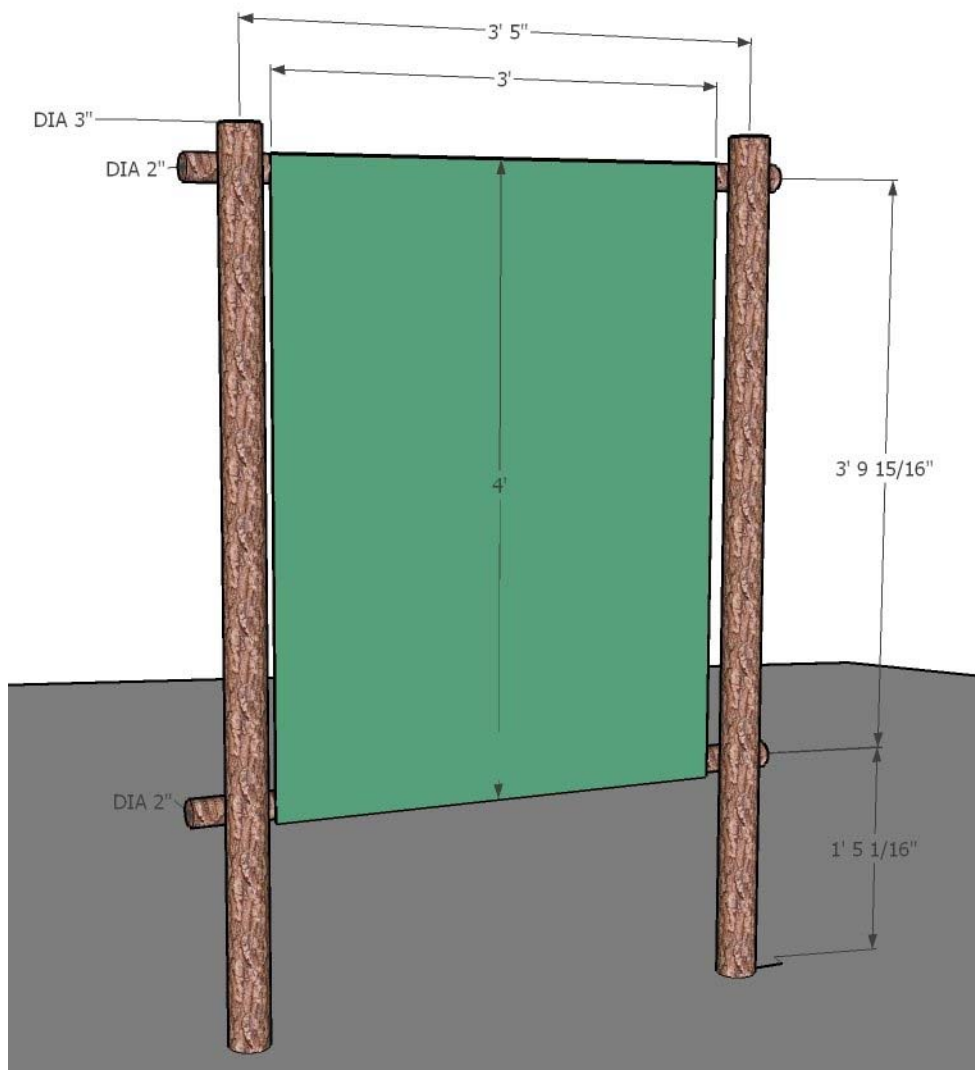


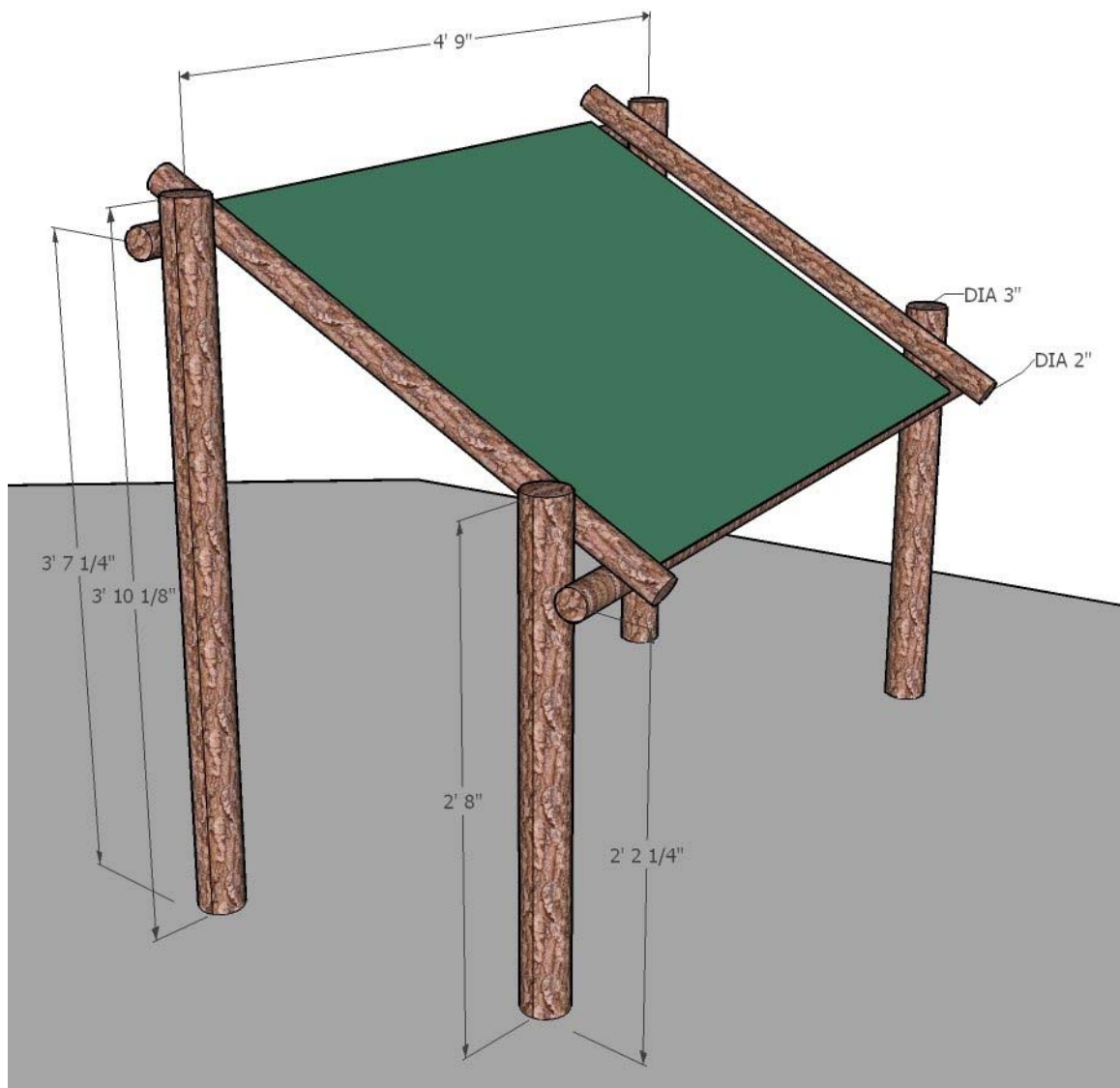
**Figure A-49: Dimensions for Outer Garden Directional Signs**

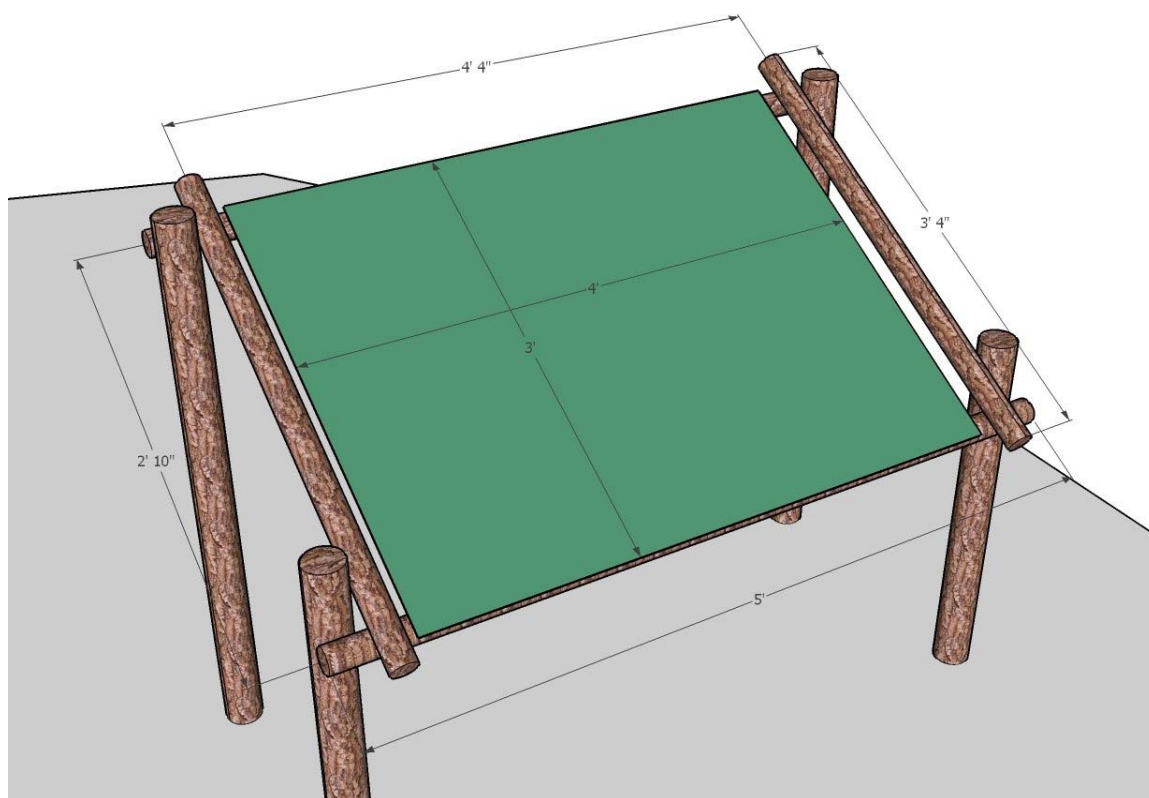


**Figure A-50: Dimensions for Outer Garden Self-Guided Tour Signs**



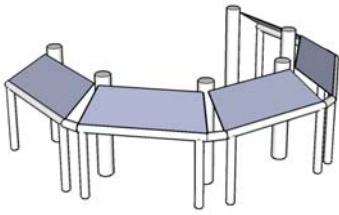
Upright Interpretive Sign Dimensions**Figure A-51: Dimensions for Upright Interpretive Signs**

Angled Interpretive Sign Dimensions**Figure A-52: Dimensions for Angled Interpretive Signs—View 1**

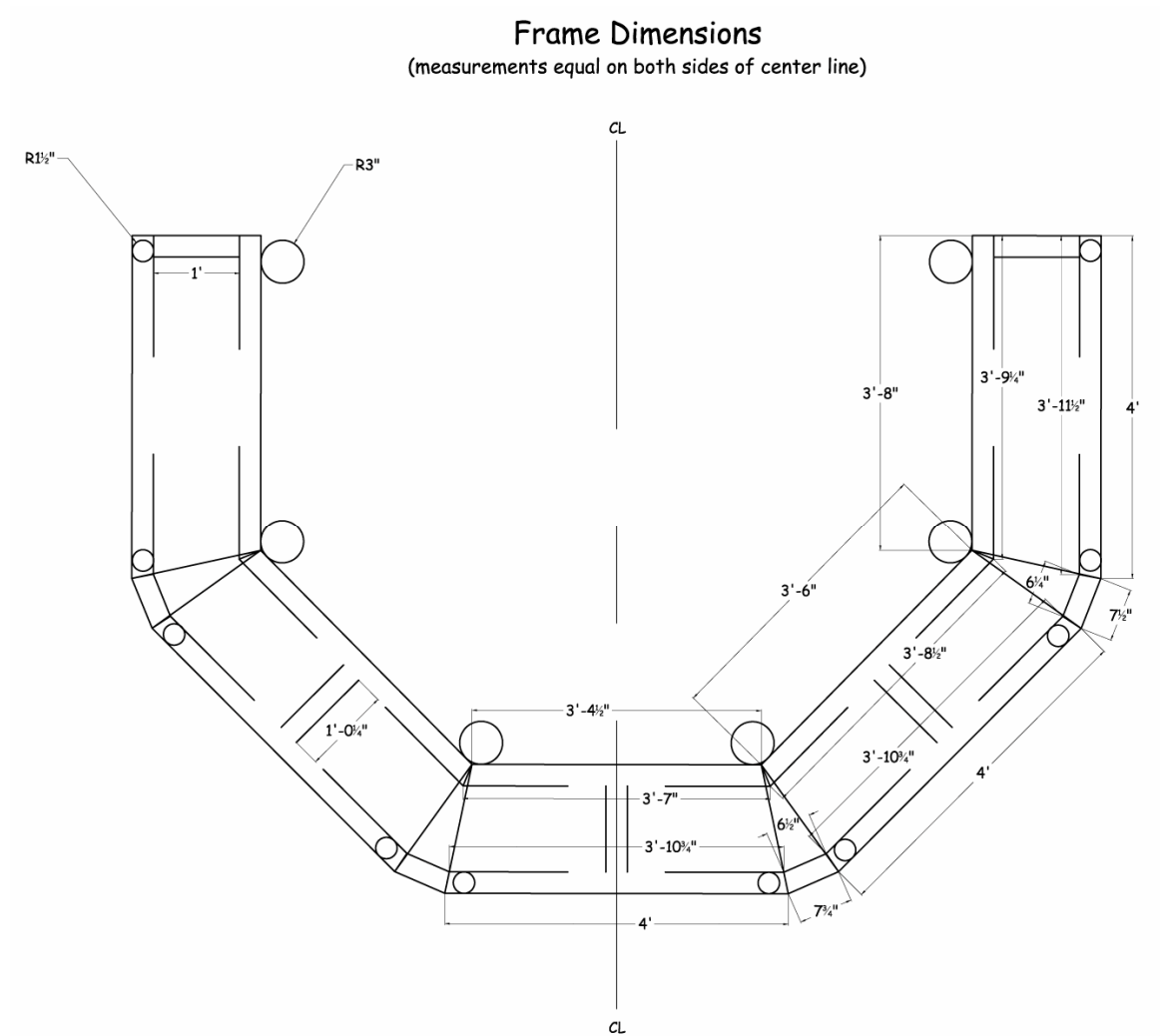


**Figure A-53: Dimensions for Angled Interpretive Signs—View 2**

# Entrance Interpretive Sign Array Dimensions

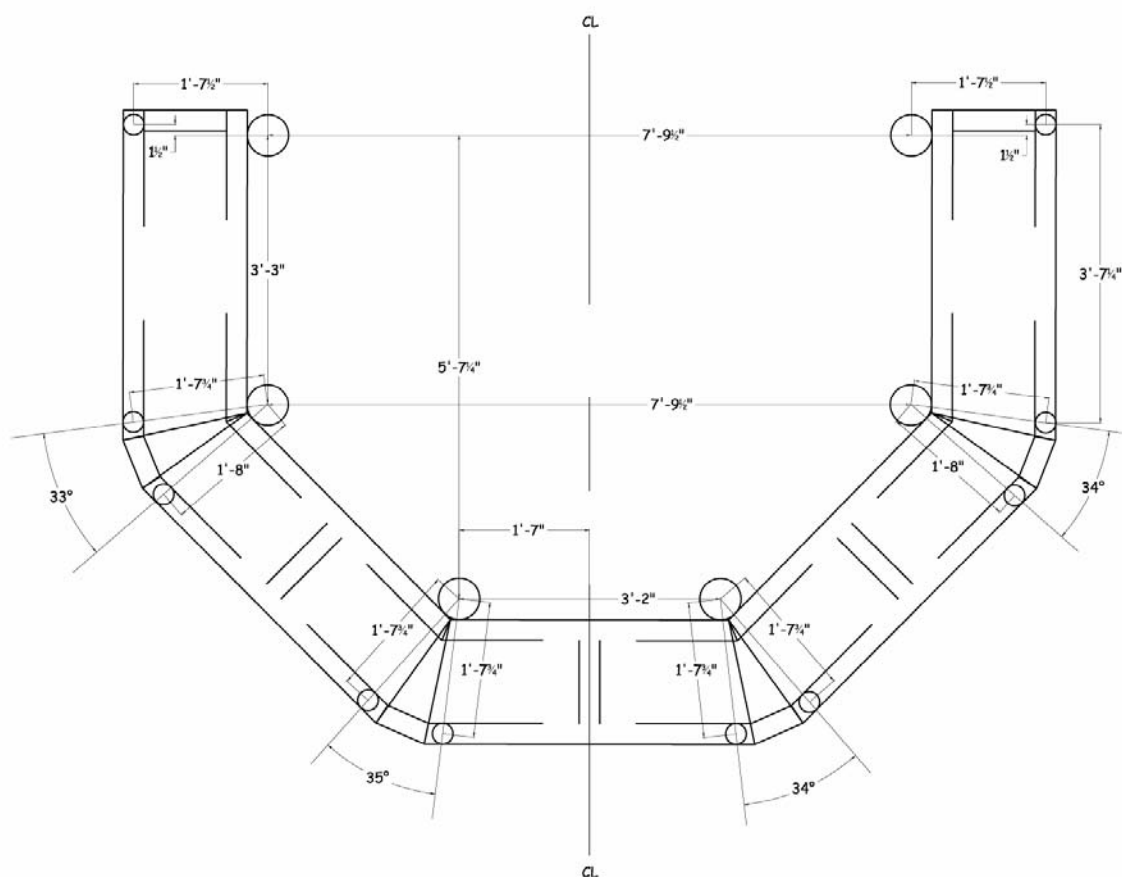


**Figure A-54: Interpretive Sign Array Model**

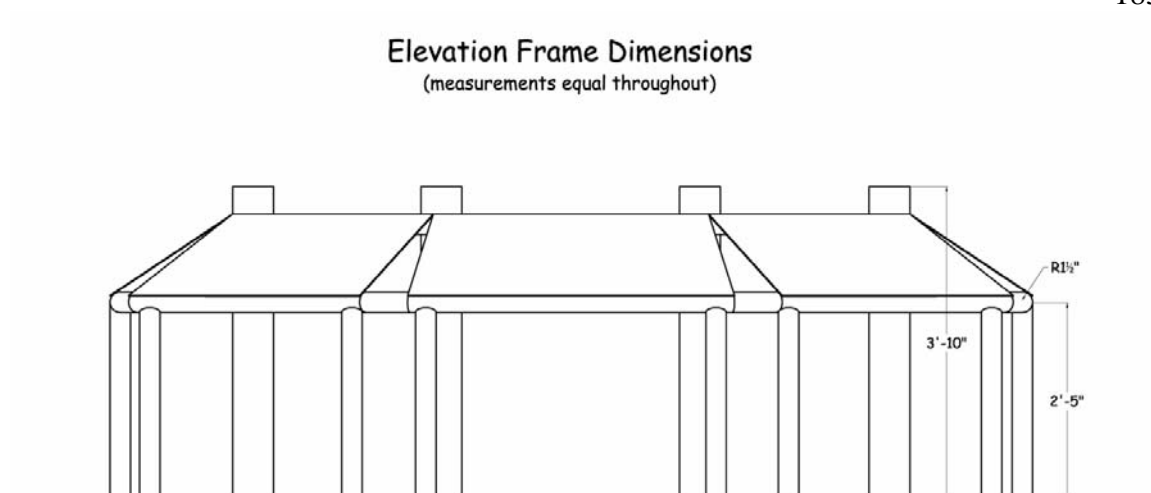


**Figure A-55: Entrance Interpretive Sign Array Dimensions—View 1**

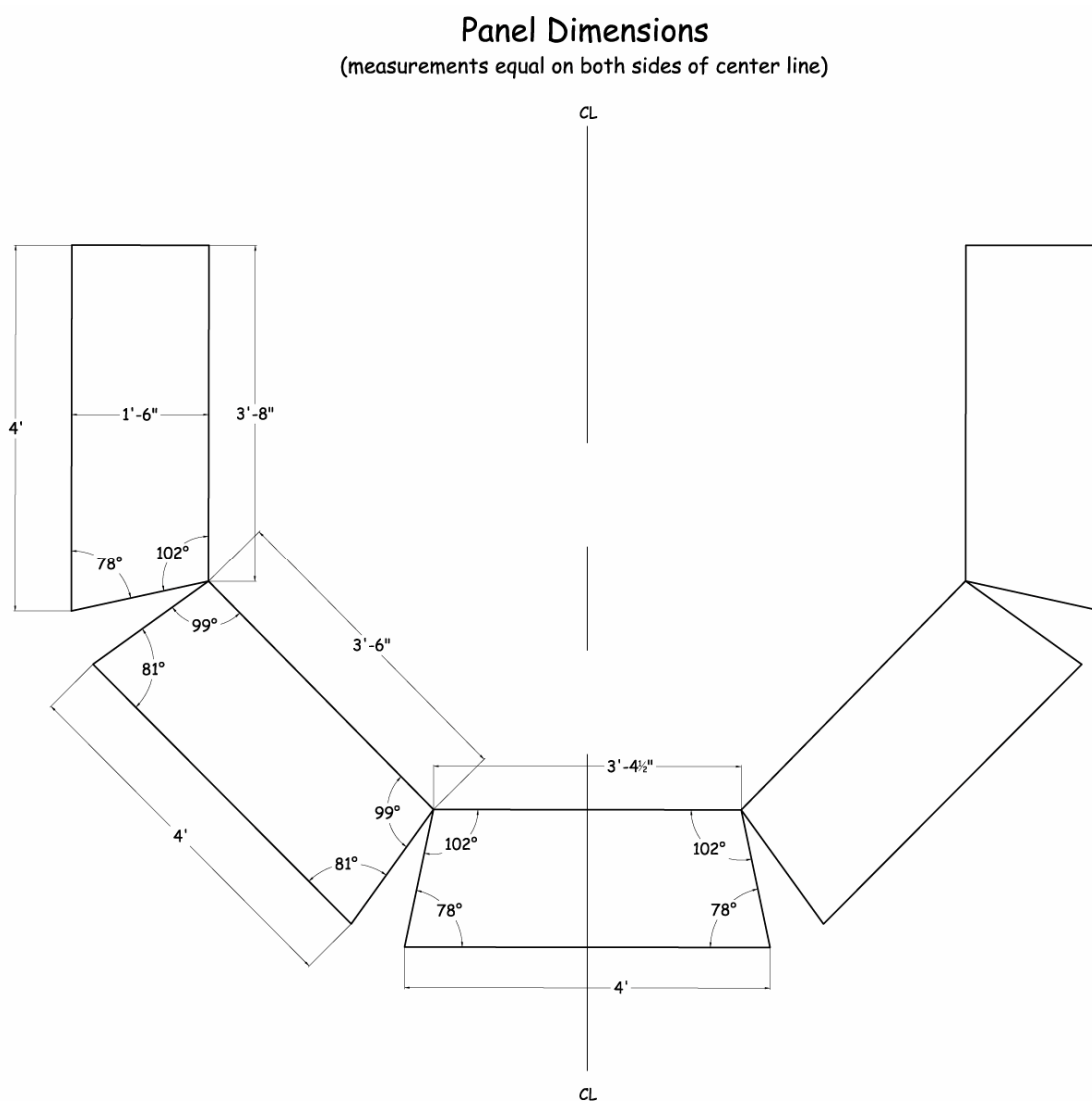
**Post Location Dimensions**  
(all dimensions are on-center)



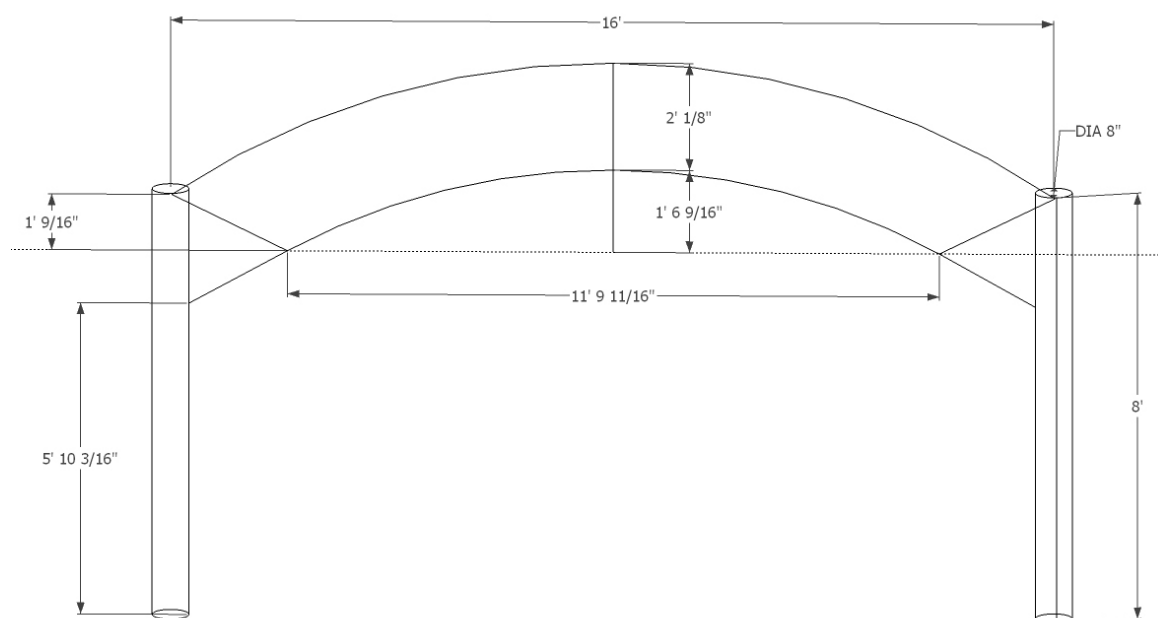
**Figure A-56: Entrance Interpretive Sign Array Dimensions—View 2**



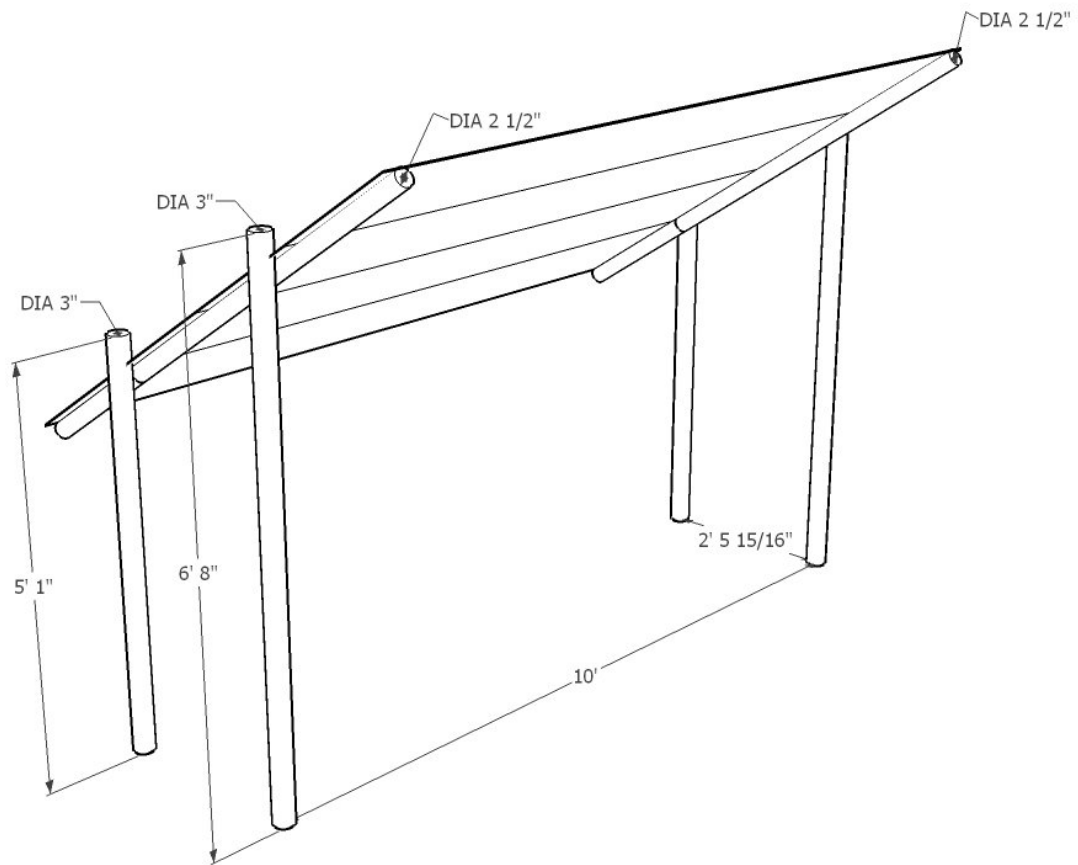
**Figure A-57: Entrance Interpretive Sign Array Dimensions—View 3**

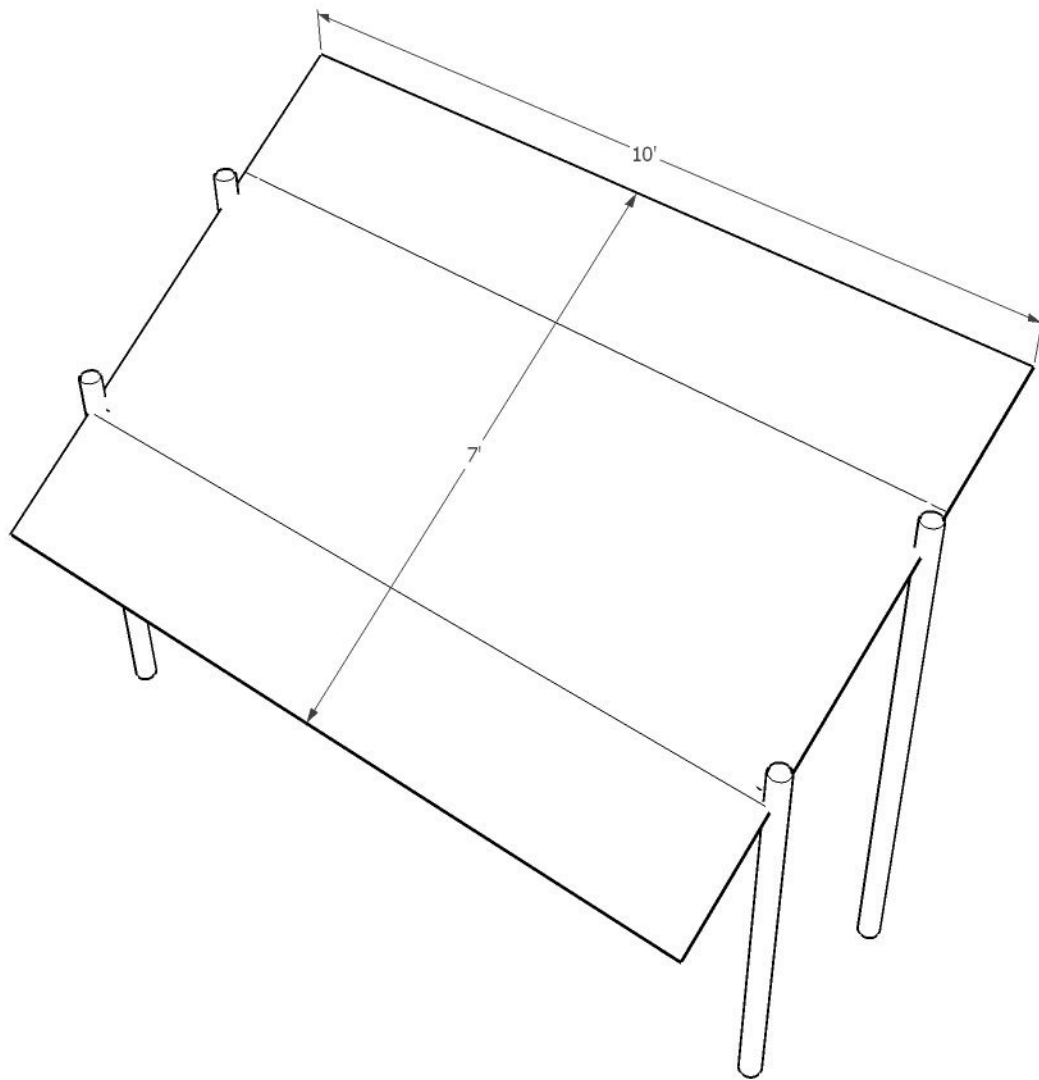


**Figure A-58: Entrance Interpretive Sign Array Dimensions—View 4**

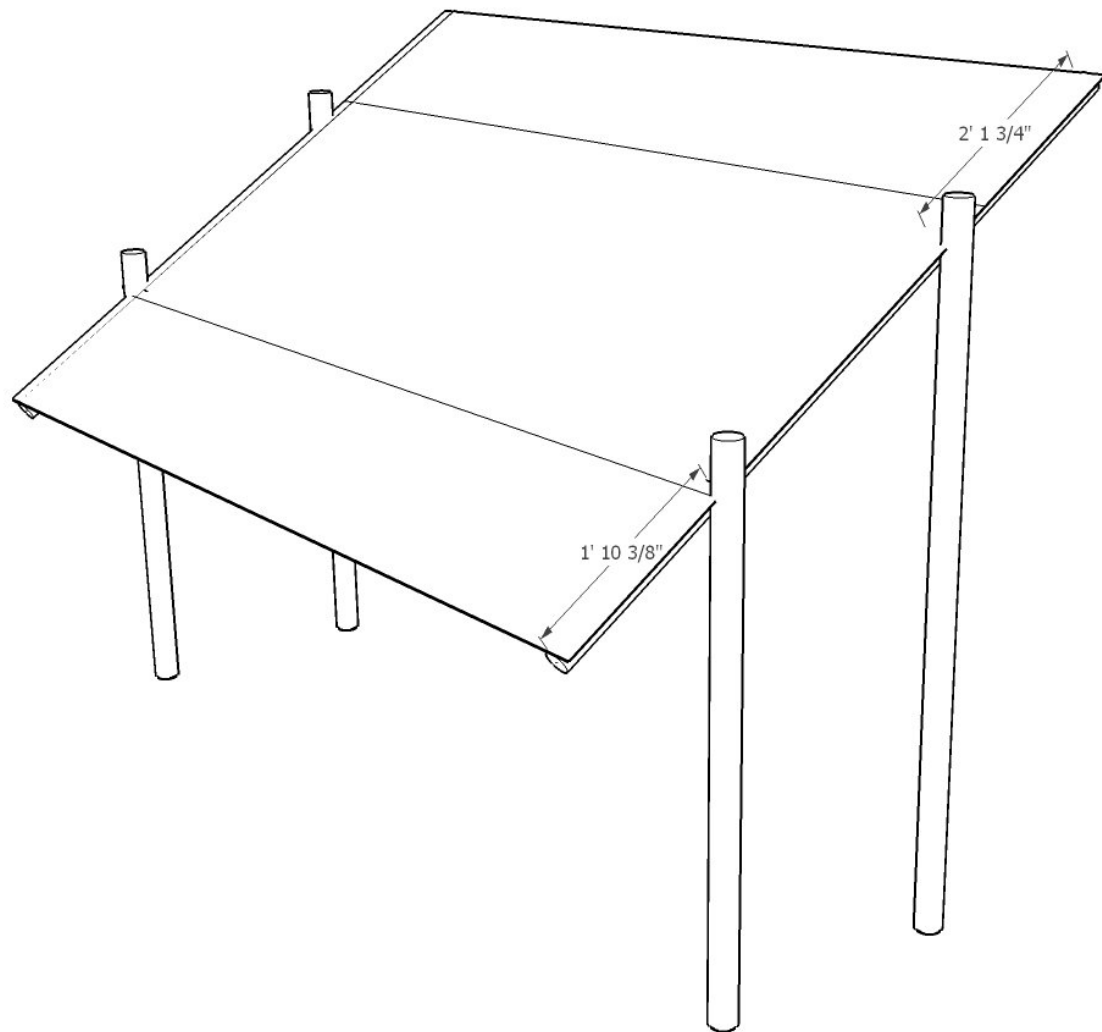
Proposed Entrance Sign Dimensions**Figure A-59: Proposed Entrance Sign Dimensions**



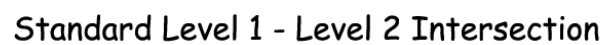
**STRUCTURE DIMENSIONS****Shade Structure Dimensions****Figure A-60: Shade Structure Dimensions—View 1**



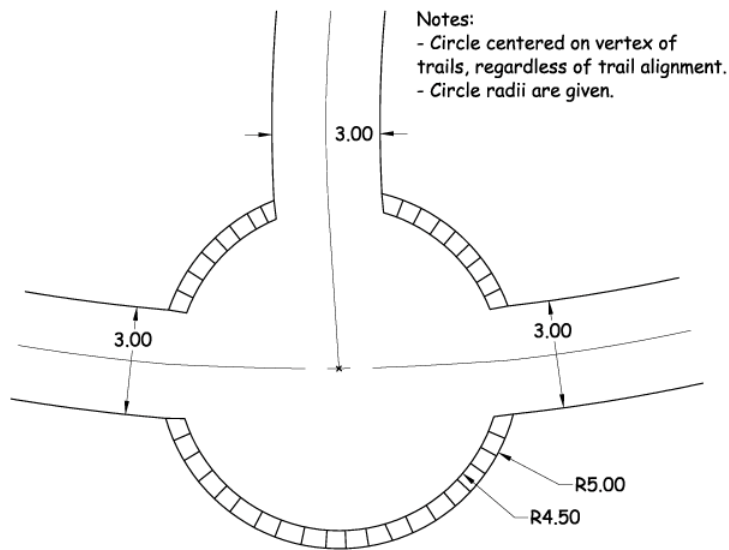
**Figure A-61: Shade Structure Dimensions—View 2**



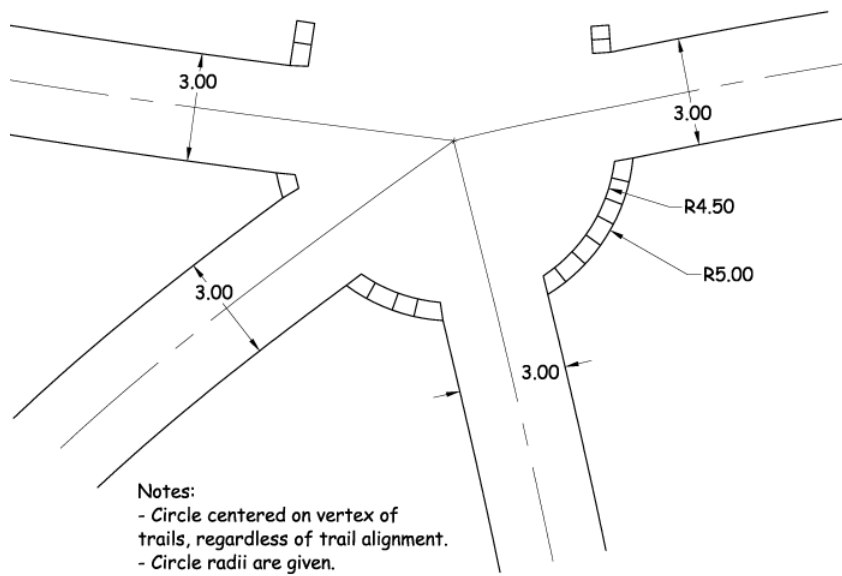
**Figure A-62: Shade Structure Dimensions—View 3**



**Figure A-63: Dimensions for Standard Intersection of a Level 1 and a Level 2 Trail**

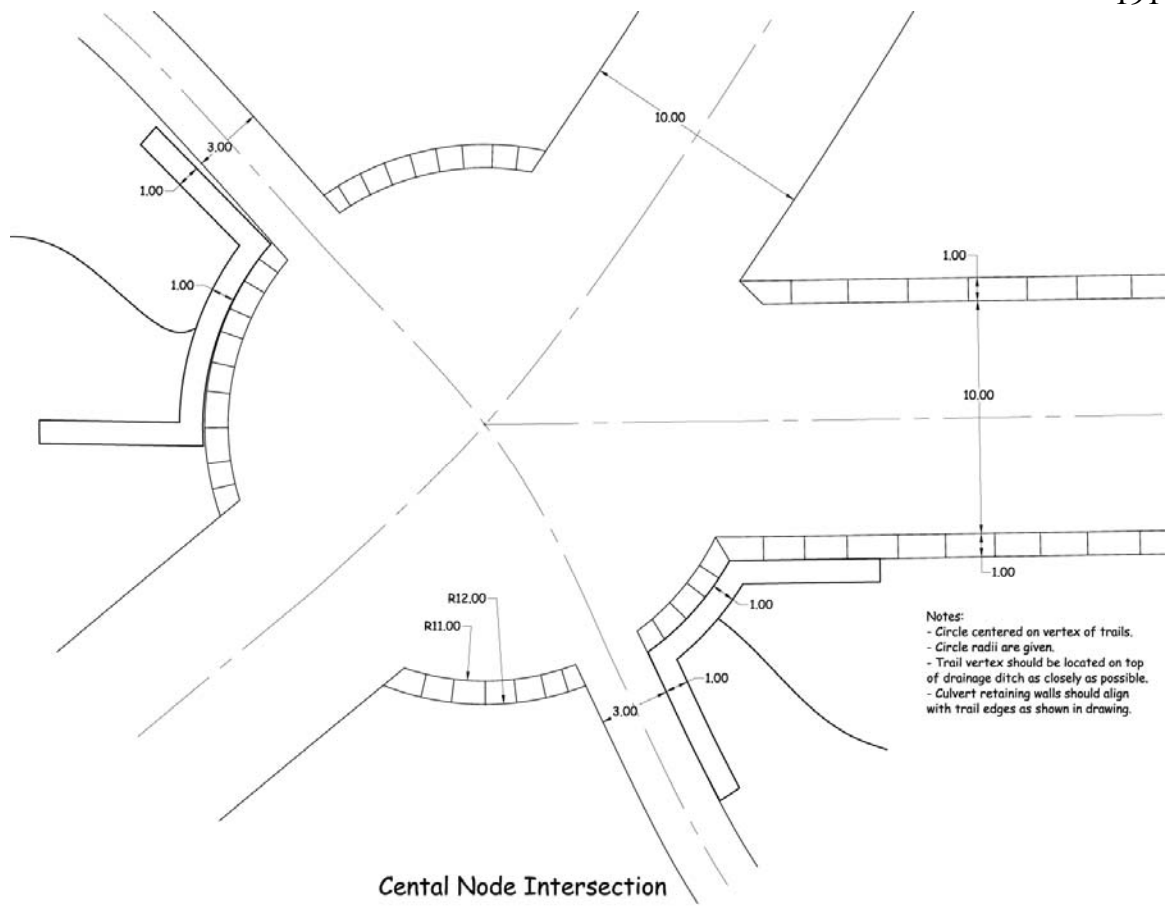


Standard Level 2 Intersection

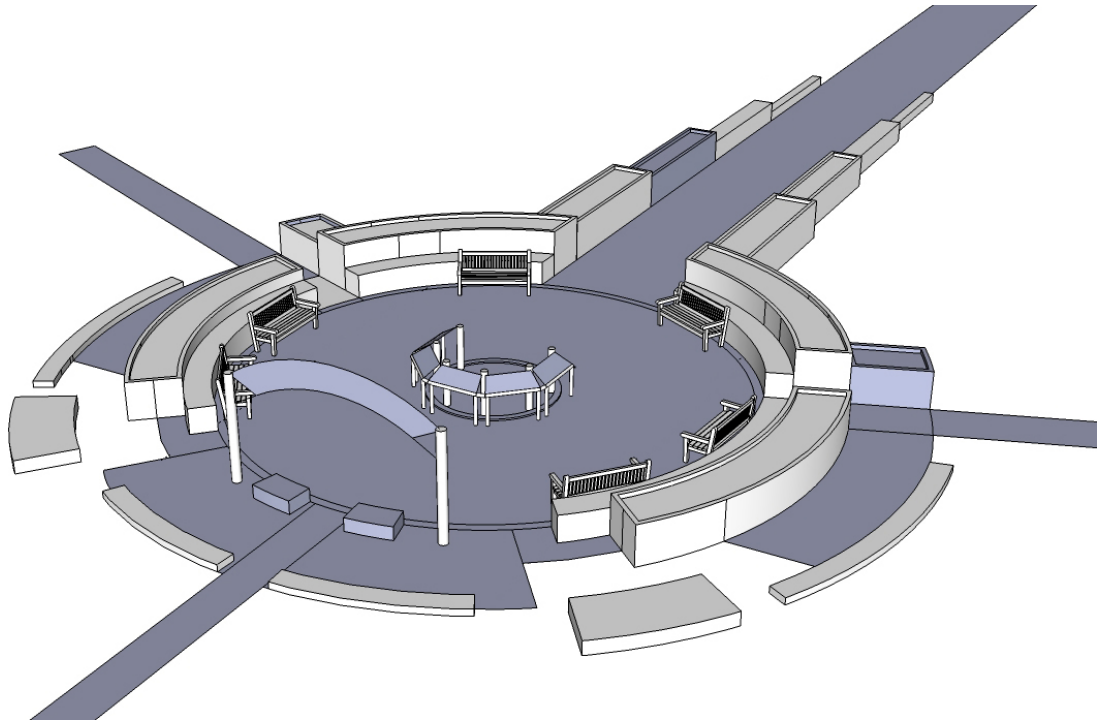


Non-Standard Level 2 Intersection

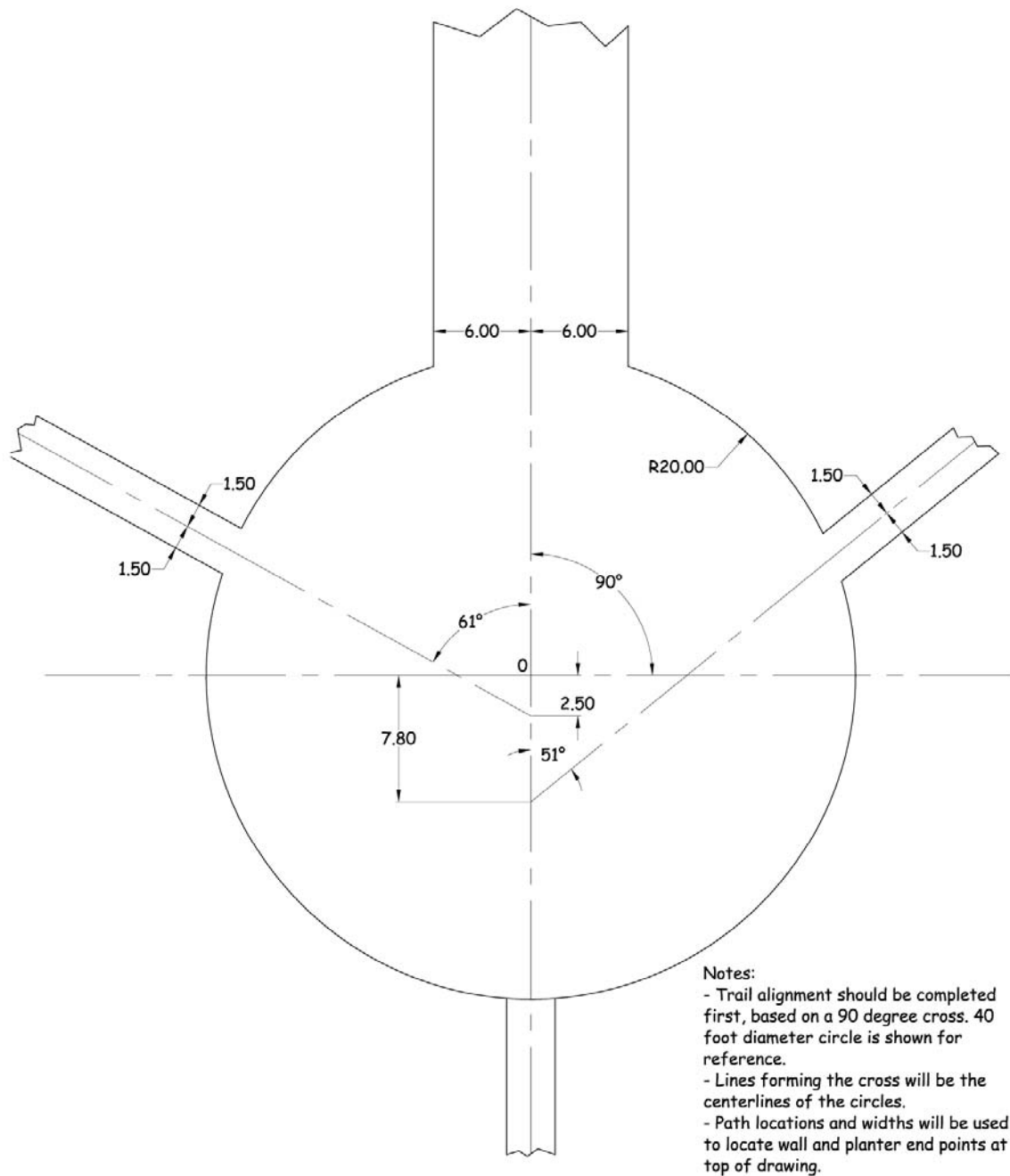
Figure A-64: Dimensions for Standard and Non-Standard Intersections of Two or More Level 2 Trails



**Figure A-65: Dimensions for the Central Node**

**ENTRANCE DIMENSIONS**

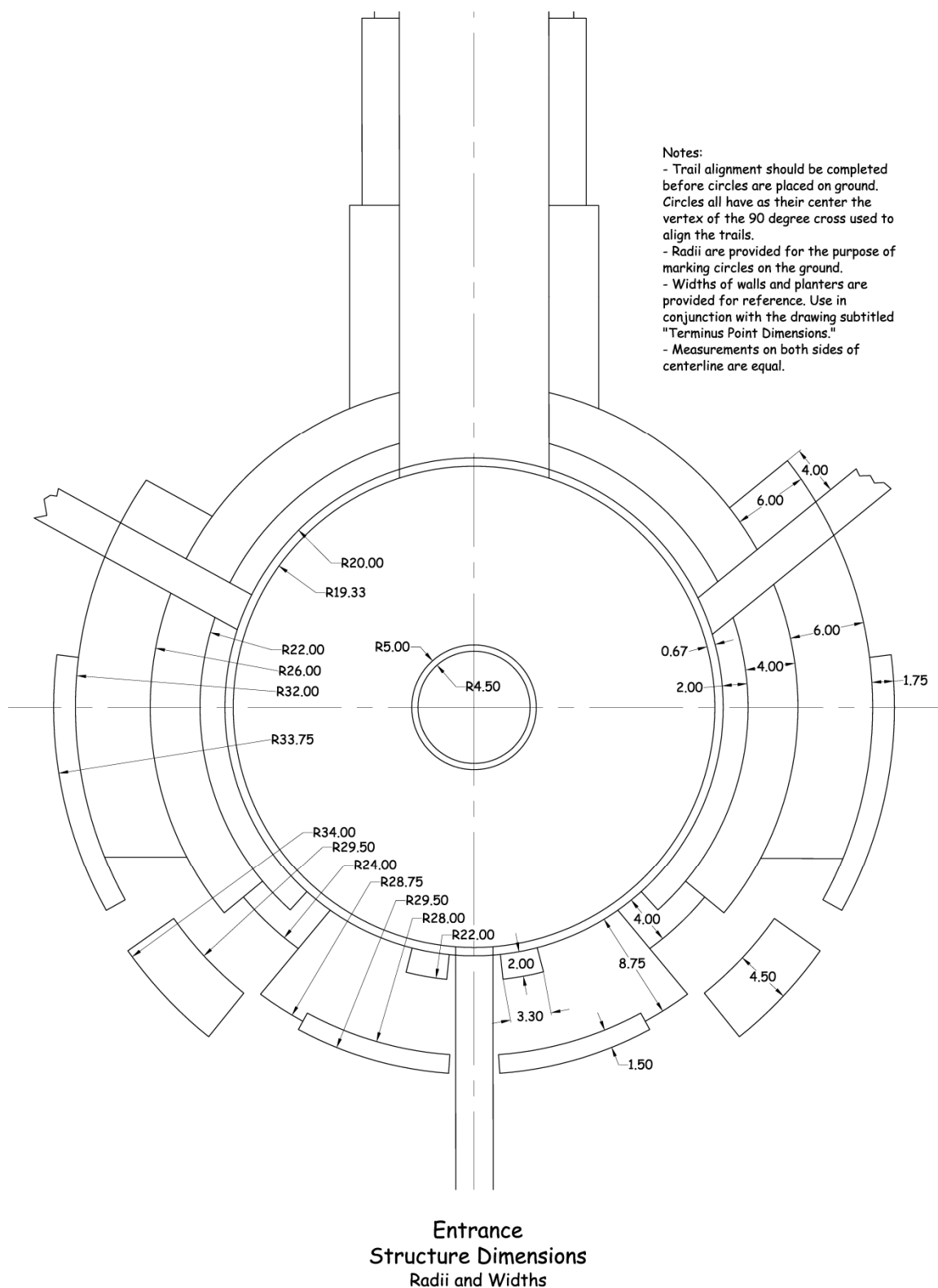
**Figure A-66: Entrance Reference Model for Dimensions that Follow**

Plan View

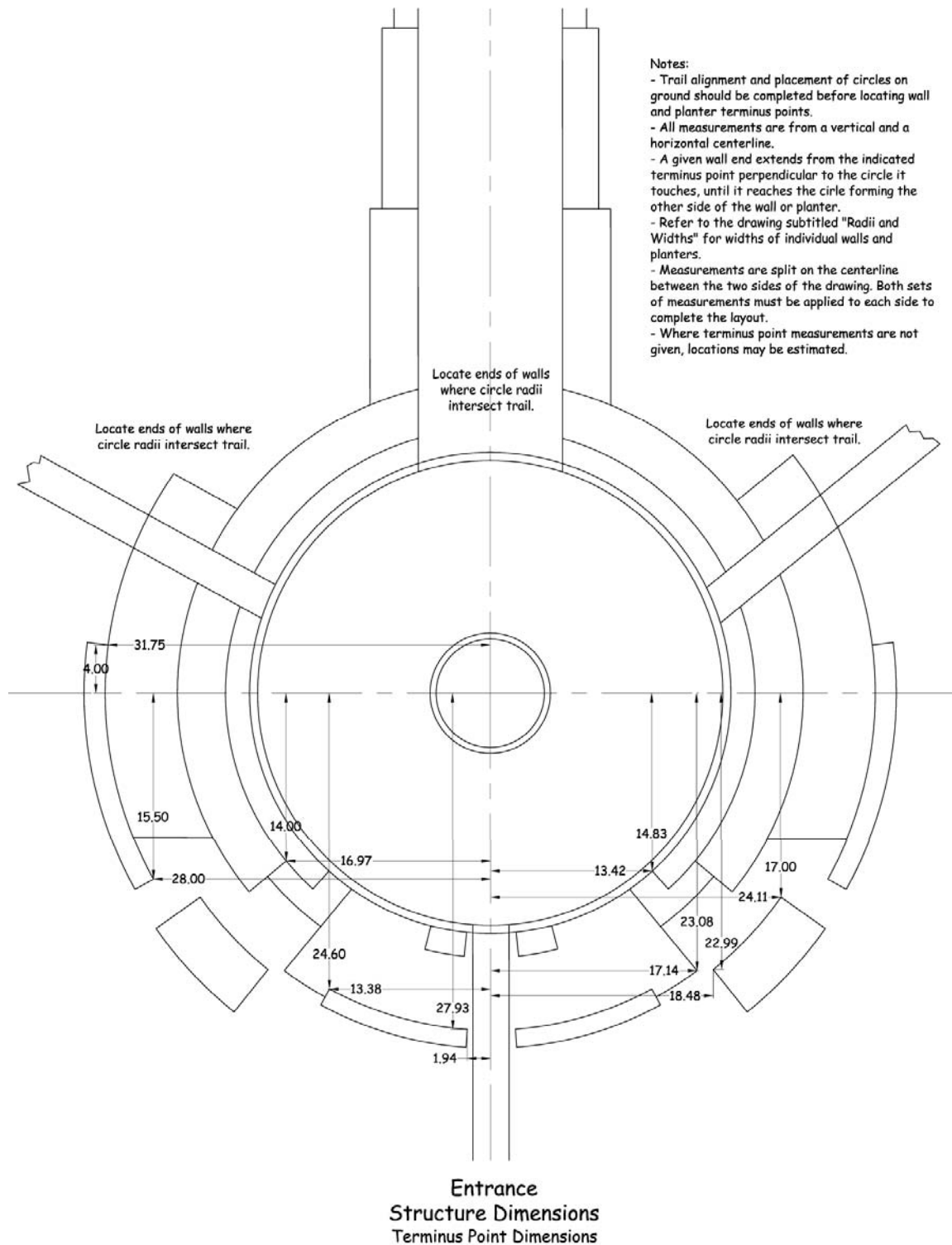
### Entrance Intersection Trail Alignment

**Figure A-67: Step One Entrance Construction Dimensions**

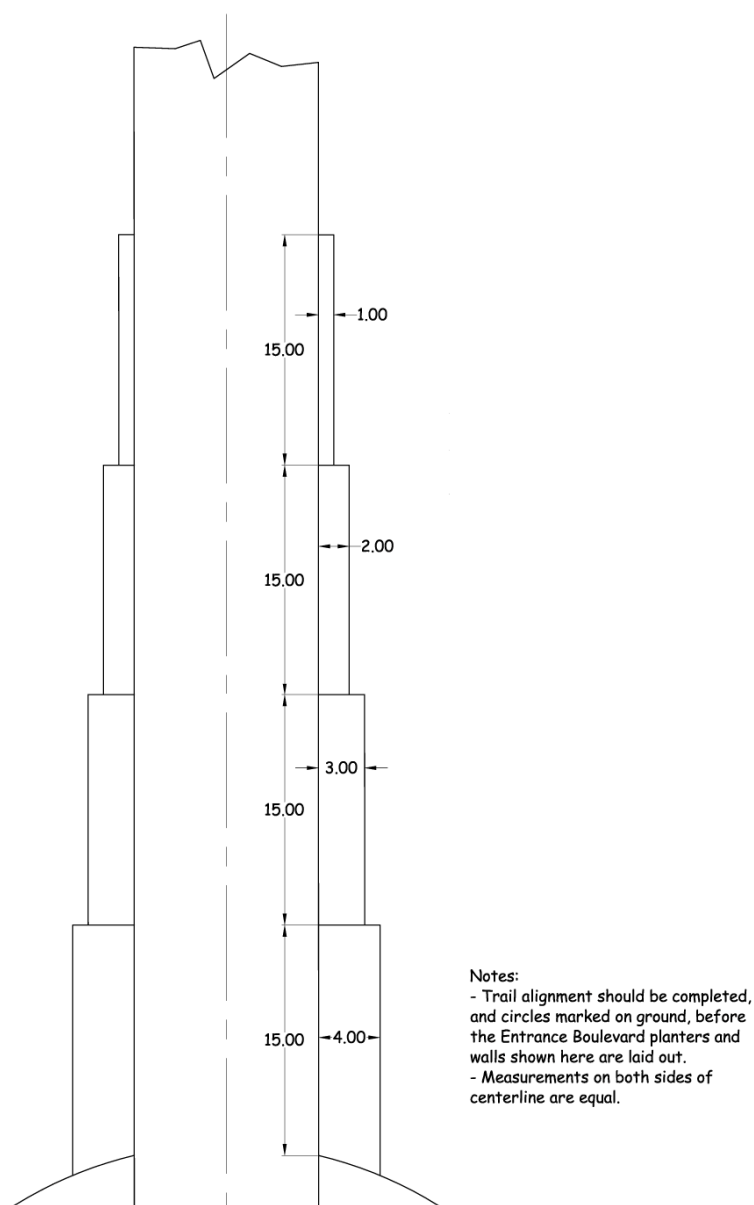




**Figure A-68: Step Two Entrance Construction Dimensions**



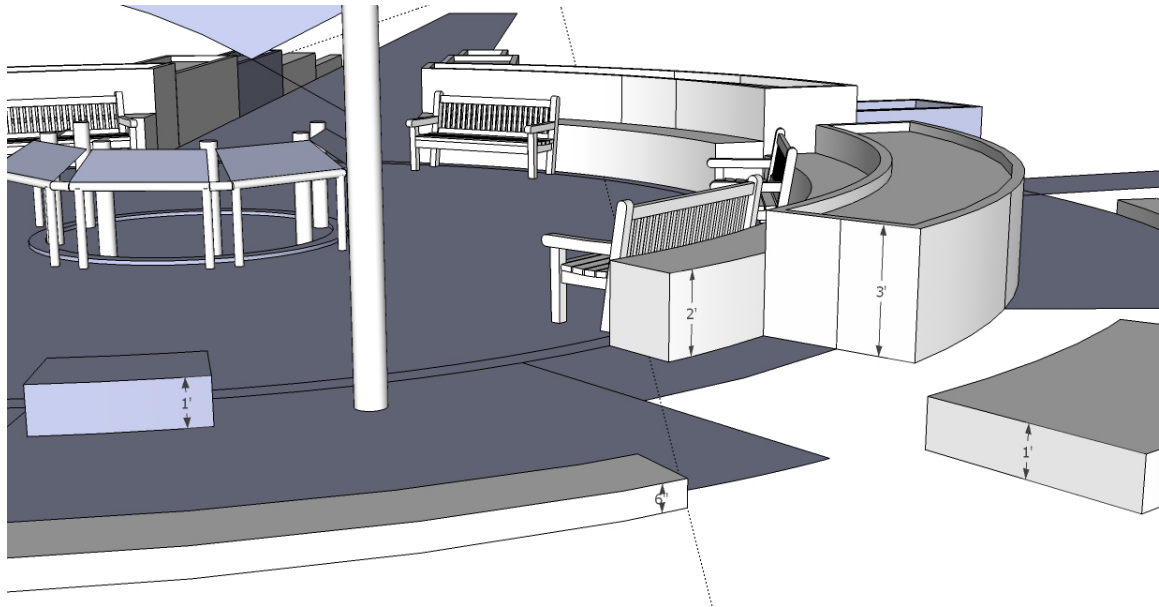
**Figure A-69: Step Three Entrance Construction Dimensions**



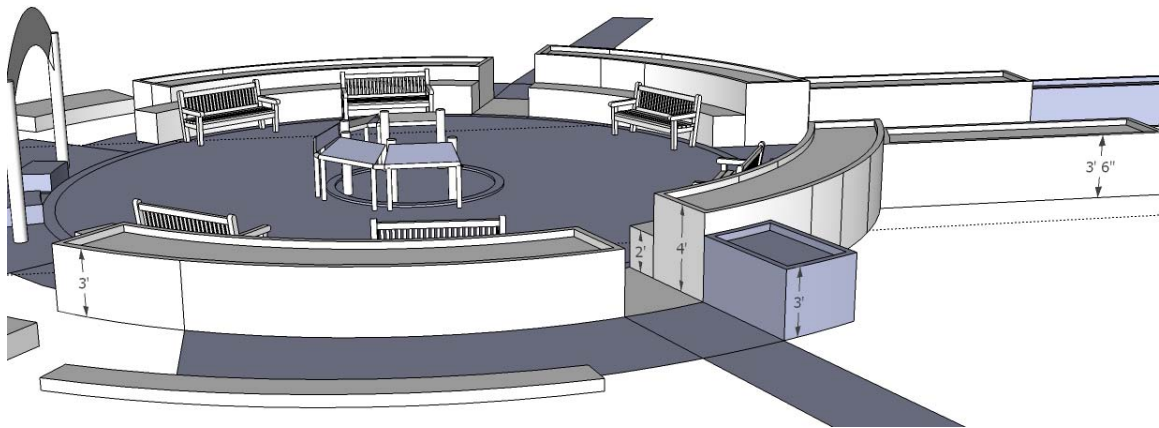
Entrance  
Structure Dimensions  
Widths on Entrance Boulevard

**Figure A-70: Step Four Entrance Construction Dimensions**

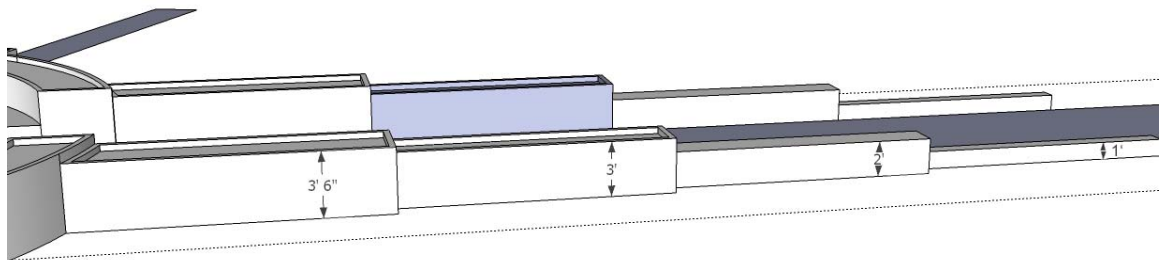
# Vertical View Three Dimensional



**Figure A-71: Entrance Vertical Dimensions—View 1**



**Figure A-72: Entrance Vertical Dimensions—View 2**



**Figure A-73: Entrance Vertical Dimensions—View 3**